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ABSTRACT

This study examined the extent to which minority individuals with baccalaureate origins as non-traditional students (baccalaureates completed at age 25 or over) completed doctoral degrees in science and engineering. It compared the efficacy of their degree completion, i.e., elapsed time and registered time to degree, with that of counterparts with traditional baccalaureate origins, along with a number of other educational and demographic attributes. This study also examined the potential of corporations and the U.S. Armed Forces as talent pools from which minority applicants for doctoral study in science and engineering could be drawn. The statistical sample comprised all Black, Hispanic, American Indian, and Alaskan Native recipients of doctorates in science and engineering for the period 1981-1990 (N=7,235) drawn from the National Doctorate Database of the National Research Council. Collaborative interviews were conducted with a small sample of the recipients. Interviews were also conducted with science and engineering corporate professionals and military personnel. Among the findings are: Minorities with non-traditional backgrounds comprised 16.9% of the doctorate recipients in the study. Nearly 27% of the non-traditionals and well over 9% of the traditionals had attended a junior or community college. The recipients were well represented in all the major fields, i.e., physical science, life science, social science, and engineering. The non-traditionals were over-represented in the social sciences. The average recipient completed the doctorate in 10.6 years after completing the baccalaureate. The groups were identical in elapsed time to degree. (PR)

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Science and Engineering Doctorate Production Among Minorities With Non–Traditional Backgrounds

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SCIENCE AND ENGINEERING DOCTORATE PRODUCTION AMONG MINORITIES WITH NON-TRADITIONAL BACKGROUNDS

HIGHLIGHTS

This study examined the extent to which minority individuals with baccalaureate origins as non-traditional students (baccalaureates completed at age 25 or over) completed doctoral degrees in science and engineering. It compared the efficacy of their degree completion, i.e., elapsed time and registered time to degree, with that of counterparts with traditional baccalaureate origins, along with a number of other educational and demographic attributes.

The study also examined the potential of corporations and the U.S. Armed Forces as talent pools from which minority applicants for doctoral study in science and engineering could be drawn.

The statistical sample for the study comprised all black, Hispanic, American Indian, and Alaskan Native recipients of doctorates in science and engineering for the period 1981-1990 (N=7235). It was drawn from the National Doctorate Database of the National Research Council. In addition, corroborating interviews were conducted with a small sample of the recipients. Interviews were also conducted with small samples of minority science and engineering corporate professionals, each with a baccalaureate or master's degree. Finally, interviews were conducted with a sample of military or former military personnel - most of whom had completed course work in the Community College of the Air Force or in Servicemen's Opportunity Colleges on or near their military bases. Purpose: exploration of potential for doctoral starts.

We found that:

Minorities with non-traditional backgrounds comprised 16.9 percent or 1220 of the doctorate recipients in the study.

Nearly 27 percent of the non-traditionals and well over nine percent of the traditionals had attended a junior or community college.

The recipients were well represented in all of the major fields, i.e., physical science, life science, social science and engineering. The non-traditionals were over-represented in the social sciences.

The average recipient completed the doctorate in 10.6 years after completing the baccalaureate. The groups were identical in elapsed time to degree.

The average non-traditional was 34.5 and the average traditional was 32.5 years of age when the doctorate was completed.

Money was the defining factor for the state of tradition or non-tradition. Fathers of non-traditional recipients were less educated than fathers of traditionals. This meant less in the way of financial support, of course, and most non-traditionals worked to save money to begin college. Or served in the military to gain veteran's benefits. This statistical finding was borne out in interviews with recipients of both groups.

Money was the key variable in efficacy in degree completion for both groups. The more substantial the support for graduate study of the recipients, the quicker they completed their degrees.

Money will be the defining factor in attracting young minority science and engineering corporate professionals to doctoral study, but potential here is substantial.

Money, time and good doctoral preparatory experiences will be the defining factors in developing young military personnel and turning them into doctoral starts. Again, the potential for this sector is substantial.

Money could be the defining factor in advancing NSF's Minority Initiative immediately. Officials of a leading scholarship foundation report that annual requests for scholarships exceed the number available by a large margin. A number of young minority corporate professionals in this study noted that they would return to school to complete a doctorate if money were available for scholarships.

ABOUT THE AUTHORS

William F. Brazziel is Professor of Higher Education and Director of Graduate Programs in Higher Education at the University of Connecticut. He has served as Distinguished Visiting Professor at the University of Wisconsin and as Distinguished Visiting Scholar at the University of New Mexico. Dr. Brazziel is author of Quality Education for All Americans and co-author of Shaping Higher Education's Future. He has completed research under grants and contracts from the National Institute of Education, the U.S. Department of Labor, the National Endowment for the Humanities, the U.S. Office of Education and the Ford, Mott and Southern Education Foundations.

Marian E. Brazziel is chairman and chief operating officer of Marian Brazziel Associates of Mansfield Center, Connecticut. She has served as a statistics professor at the University of Connecticut, as an NASA statistician and as a United States Patent Officer. She is the co-author of VGH Data for a Twin Engine Jet During Airline Operations and Initial Report on Operational Experiences of General Aviation Aircraft. Dr. Brazziel has completed research under grants and contracts from the National Endowment for the Humanities and the Ford, Mott and Southern Education Foundations.

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SCIENCE AND ENGINEERING DOCTORATE PRODUCTION AMONG MINORITIES WITH NON-TRADITIONAL BACKGROUNDS

BACKGROUND AND STUDY DESIGN

The purpose of this study was to examine the extent of science and engineering doctorate production among minorities with non-traditional baccalaureate origins and to identify the correlates of their efficacy in completing the doctorate. A second purpose of the study was to explore corporations and military installations as non-traditional sources of minority science and engineering doctoral students.

If significant changes are not effected in our talent conservation and talent development system, our initiatives to increase the numbers of minority science and engineering doctorate recipients will fall short of our goals. They may even approach abject failure. There is a growing lack of congruence between traditional approaches for searching out and grooming bright young people for doctoral study and the increasingly unique college attendance patterns of minority students (Richardson, 1987; American Council on Education, 1988; Lee and Frank, 1990).

Presently, we reach only about half of the bright minority youngsters with the encouragement and mentoring necessary to guide them into doctoral study. In five years we will probably reach only 40 percent or so (American Council on Education, 1988). Data on the production of minority doctorates in engineering and science are both discouraging and familiar to all. Annual reports from the National Research Council's doctorate surveys document the need for measures designed to increase production (National Research Council, 1970-90). The 1990 report of the Council offers data which encapsulates the need for concern on a single page (page 66). Of the 5460 physical science doctorates won by U.S. citizens and non-citizens with permanent visas in 1989, only 44 were won by blacks and 84 by Hispanics. Engineering was worse. Blacks won 32 and Hispanics 47 of the 4536 degrees awarded. Consider that these two groups alone will comprise 30 percent of the population by the year 2000 and 40 percent of the workforce (American Council on Education, 1988). In response to this widely discussed need, a national drive to improve the situation (The NSF Minority Initiative), referred to throughout the study, was launched by the federal government. The challenge now for all concerned individuals is to assure success for the effort.

Science and engineering students who go on to win doctorates are singled out in the freshman and sophomore years by professors who see promise in them and informally suggest that they think about pursuing doctoral study. These students are discussed in faculty meetings and faculty groups and begin to receive encouragement from all quarters. They are asked to help around the laboratories, work on experiments, co-write papers, attend conferences, read papers at conferences and more. They network with other students, on campus and elsewhere, who are headed to doctoral study. They work in study groups of the same ken. They buy practice manuals and software early on and begin the three or four years of practice and preparation many bring to the Graduate Record Examination testing sessions.

In the junior year the chosen ones begin the search for fellowships and assistantships, all under the tutelage of mentors. Letters attesting to four years of careful observation of promising talents are forwarded by mentors and other professors. By the second semester of the senior year, their entrance to study for the doctorate is set. The acceptance letters are in hand. So are the assistantships and fellowships.

As noted above, this remarkable - and highly effective - system is available to only about half of bright minority students. Economics preclude the attendance of the other half at the colleges and universities where the system is in place. Forty-three percent of black college freshmen attend community colleges, for example. (American Council on Education, 1988; U.S. Census Bureau, 1988; Brazziel, 1988; Richardson, 1987). Many are very bright, but cannot afford to go to a school where the talent conservation and development system is in place. A growing number of whites are joining minority students at community colleges as costs for college climb ever higher (Lee and Frank, 1990). Poor minority students must work to save money to begin college. Others serve in the military to qualify for the GI Bill. These students complete college late (age 25 and over) and comprise a large number of non-traditional students.

In response to rising college costs, a growing number of potential science and engineering students from minority groups have enlisted in the military services. Almost to a person, they state the desire to study a high-tech field of study in the fine military schools as one of the reasons for their enlistment. Their Armed Forces Qualifications Tests and high school records indicate that their abilities match or exceed those of their civilian counterparts and that the top two percent could prepare for, and eventually enter and succeed in, doctoral programs. Many of these students begin their college careers through college programs offered on or near military bases. Others attend The Community College of the Air Force, now America's largest college (520,000 students) and one of its more respected technical institutions. As an indicator of fast-changing times, CCAF did not exist 20 years ago. As good as these military schools are, however, the talent conservation and development system to prepare bright youngsters for entry to science and engineering doctoral programs is not in place in them (Levine and Associates, 1989). The potential is there, however, and these schools may comprise excellent talent pools.

Further, in this vein, a growing number of bright minority youngsters are entering the workforce and attending college on a part-time basis (American Council on Education, 1988). Like their counterparts in community colleges and the military, they cannot benefit from the talent conservation and development system because of the simple fact that they are not around the professors, laboratories, study groups, conference travel and networking which comprise the system - to any great extent. This is a handicapping condition for commuter students and it takes it toll on their development (Astin, 1984).

Finally in this vein, many minority science and engineering baccalaureates enter and take APONSI courses for college credit. Well over 400 corporations now offer APONSI programs (A Program of Non-Collegiate Sponsored Instruction) and the number is growing. The quality of the instruction in these programs is exquisite, to say the least, and science and engineering courses abound in the offerings (Eurich, 1967; Levine and Associates, 1989; Brazziel, 1985). General staff development programs also offer many advantages to the new corporate worker. In short, corporations may comprise excellent pools for minority science and engineering doctoral starts.

Problem Statement

It is both unwise and imprudent to try to mount a national drive to increase minority science and engineering doctorates when it is crystal clear that necessary talent conservation and talent development experiences will reach less than half of the targeted population, the other half being non-traditional students, in the context of experiences of the average pre-doctoral science and engineering student.

We need to learn as much as possible about minority students who completed their baccalaureate careers as non-traditional students and who managed to go on to win science and engineering doctorates. We can then begin to effect change in the talent conservation and talent development system with an eye toward involving non-traditional students to the greatest extent possible. In this vein, we need to identify the personal attributes and environmental circumstances which made for the successes of these remarkable individuals (the non-traditional doctorate recipients), what psychologist refer to as enabling attributes and circumstances. We then need to share the implications for changes in talent conservation and talent development systems with those in charge of mounting initiatives for increasing minority science and engineering doctorate recipients. Finally, we need to explore new sources of minority doctoral students - new talent pools, both on campuses and off campuses.

Purpose of the Study

Again, the purpose of this study was to examine the extent of science and engineering doctorate production among minorities with non-traditional baccalaureate origins, along with the correlates of their efficacy in completing the doctorate. A second purpose of the study was to explore corporations and military installations as non-traditional sources of minority science and engineering doctoral students - as possible new talent pools.

Methodology

Data sets for black, Hispanic, American Indian and Alaskan Native science and engineering doctorate recipients who completed their baccalaureates as non-traditional students, i.e., individuals who completed their baccalaureates at age 25 or later comprised our sample. It included minority science and engineering doctorate recipients who completed their degrees in the ten-year period 1981-90. Data for these recipients were drawn from the National Doctorate

Survey Database. Data sets for a companion group consisting of the balance of the subjects in these groups, the traditional students, were drawn and used for comparison purposes. The same time frame (ten years) obtained.

Using descriptive statistics, profiles for each group were developed and compared. The profiles included the elements of non-traditions, e.g., nature of college beginnings, e.g. attending junior or community college, plus key elements of doctoral study such as age, sex, education of parents, sources of support, elapsed time to degree and total registered time to degree.

Using inferential statistics, e.g., regression and analysis of variance, profile data were tested for their importance as enabling attributes, i.e., predictors that enhanced efficacy in the completion of the degree. Efficacy was defined here as minimal elapsed time to degree and minimal registered time to degree (Brazziel and Brazziel, 1985). Predictors (enabling attributes) of efficacy in doctoral completion for the groups (traditional and non-traditional student doctorate recipients) were then compared. Implications for talent conservation and talent development initiatives were then drawn, e.g., extending the system, recruitment of prospects, provision of added resources et al.

To corroborate the perceptions and insights gained from the statistical analyses, we interviewed 12 minority science and engineering doctorate recipients with traditional baccalaureate origins and 10 such individuals with non-traditional baccalaureate origins. These subjects were identified through consultations with foundation officials, and graduate school deans and department chairpersons across the nation. This information validated results of the statistical analyses and enabled us to grasp many nuances of the non-traditions outlined above. Implications were drawn.

To explore corporations and military installations as non-traditional sources of minority science and engineering doctoral students, we interviewed 11 minority science and engineering corporate professionals and ten young soldiers, airmen, national guardsmen, all either on active duty or recently discharged from the Armed Forces. All were enrolled in science or science-based technology courses on their bases or at nearby colleges, or had completed such courses and transferred them into science and engineering programs at universities.

Again, many bright but poor minority students begin their college careers while serving in America's Armed Forces. A recent College Board study noted that college costs rose 123 percent in the last decade but student financial aid only rose 62 percent, and that students from homes with modest incomes were being squeezed out of college (College Board News, 1990). As a consequence, the Armed Services have emerged as a reservoir of minority talent and wise colleges and universities might do well to tap this talent and head some of those young people with science and engineering talent toward doctorates in science and engineering. NSF's Minority Initiative should be in the forefront of this effort.

What has been said above about the attraction of the military for talented minority student can be said, to an extent, about large corporations. Along with the military and state and federal government agencies, large corporations work hard at equal opportunity and some have achieved a fine record of success.

Many minority four-year graduates leave college owing considerable amounts in college loans. Most of these students forego graduate school because of these debts and opt for corporate work. Many work as programmers, chemists, and in similar science-based jobs. They and their counterparts above are prime candidates for further study and, perhaps, study for the doctorate degree. The interviews employed search for grounded theory as enunciated by Glaser and Strauss (1967). This procedure employs guided interviews to begin the exchange with the subjects. Interviewers then move to a free-flowing exchange usually focusing on a stated problem which both the interviewee and interview agree should be addressed. In our case the problem was making NSF's Minority Initiative work. View and philosophy emerge in this process. Both are duly noted and are analyzed in post-interview reflections. Theory, pre-suppositions and the like do not intrude in post-session reflections. The mind is free to develop impressions of cause and effect of phenomena at will.

About the Interviewees. Interviews were conducted with minority doctorate holders who began and completed their college careers as traditional students. Interviewees were based at corporations in the Washington, D.C. metropolitan area. These included Rand and ASCI. Interviews for this group were also conducted with faculty members at the Universities of Connecticut, Florida, Central Florida, South Florida and Kansas. More interviews for this group were conducted with faculty at Florida State University and Miami University of Ohio and with corporate professionals at Bell Communications Systems of Red Bank, NJ and the City of Hope National Medical Center of Duarte, CA.

Interviews were conducted with minority doctorate holders who began their college careers as non-traditional students. These interviewees were based at corporations in the Washington, DC and Northern Virginia metropolitan areas, at the U.S. Center for Disease Control in Atlanta, Bell Communication Systems of Red Bank, NJ and at the Rohm Haas Corporation of Springhouse, PA. Interviews for this group were also conducted with faculty members at Virginia Commonwealth University, Dillard University, Alabama A&M University and the University of Connecticut.

Interviews were conducted with corporate employees who were enrolled or had been enrolled in corporate or college courses in the St. Louis metropolitan area.

These firms included the Monsanto, Mallinkrodt, and McDonnell-Douglass Corporations, among others.

Interviews were conducted with military persons at Westover Air Force Base of Chicopee, MA. and at the Massachusetts National Guard Armory at Springfield, MA. Interviews were also conducted with recently discharged veterans at the University of Connecticut who had transferred in college credits earned in the Community College of the Air Force and in Servicemen's Opportunity Colleges.

In addition to the co-principal investigators, the following individuals conducted interviews:

Dr. Karl Beeler
University of Missouri-St. Louis

Janice Hamilton Outtz
Center for Demographic Policy
Washington, DC

Lawrence Williams
University of Connecticut

Robert McGann
University of Connecticut

Robert Malavenda
University of Connecticut

FINDINGS: STATISTICAL ANALYSES

Traditional and Non-Traditional Student Minority Science and Engineering Doctorate Recipients: Demographics

A total of 7235 minority students received science and engineering doctorates for the ten-year period 1981-1990. A total of 6015 of these recipients (83.1 percent) were traditional student doctorate recipients, i.e., recipients who began their college careers as traditional students. A total of 1220 of the recipients (16.9 percent) had baccalaureate origins as non-traditional students, i.e, had completed their baccalaureates at age 25 or later. (See Table 1.)

Table 1

Number and Percent of Minority Science and Engineering Doctorate Recipients With Traditional and Non-Traditional Baccalaureate Origins: 1981-90

Baccalaureate Origin	Number of Recipients	Percent
Traditional	6015	83.1
Non-Traditional	1220	16.9
Total	7235	100.0

Racial and Ethnic Representation. Five of the six racial and ethnic groups as defined by the National Research Council in its database were represented in the sample. (See Table 2.)

Table 2

Race and Ethnic Group of Minority Science and Engineering Doctorate Recipients With Traditional and Non-Traditional Baccalaureate Origins: 1981-90

Group	Traditional		Non-Traditional	
	No.	%	No.	%
Black	2826	47.0	712	58.4
Mexican-American	693	11.5	123	10.1
Puerto Rican	696	11.6	47	3.8
Indian/Alaskan Native	347	5.8	74	6.1
Other Hispanic	1453	24.2	264	21.6
Total	6015	100.0	1220	100.0

Chi-Square significant at .05 level

Asians were not included in this study to allow for full attention to minorities seriously underrepresented among science and engineering doctorates. As Table 2 shows, black Americans led the list with 2826 recipients with traditional and 712 recipients with non-traditional baccalaureate origins. They were followed by Hispanics with 1453 and 264 recipients respectively, Mexican Americans with 693 and 123 recipients and Puerto Ricans with 696 and 47 recipients. Indians and Alaskan Natives had 347 recipients with traditional and 74 with non-traditional baccalaureate origins.

Gender. Table 3 indicates that males outnumbered females in both the traditional and non-traditional groups, 3557 to 2458 for the former and 862 to 358 for the latter. The ratios 59.1 to 40.9 and 70.7 to 29.3 correspond roughly to gender ratios for all doctorate recipients. In 1990, women received 36 percent of all doctorates and 28.1 percent of science and engineering doctorates (National Research Council, 1991).

Table 3

Gender of Minority Science and Engineering Doctorate Recipients With Traditional and Non-Traditional Baccalaureate Origins: 1981-90

Gender	Traditional		Non-Traditional	
	No.	%	No.	%
Male	3557	59.1	862	70.7
Female	2458	40.9	358	29.3
Total	6015	100.0	1220	100.0

Chi-Square significant at .05 level

Age. Predictably, doctorate recipients with traditional baccalaureate origins completed their degrees at an earlier age (32.5 years) than recipients with non-traditional baccalaureate origins (34.5 years). The standard deviations were small for a sample this large (N=7235). Cumulative percent distributions indicated that 85 percent of the non-traditionals completed their degrees by age 45, 63 percent by age 40 and well over half by age 38. In contrast, the median age for all science and engineering doctorate recipients in 1990 was 32.6 (National Research Council, 1991).

Table 4

Mean Age at Degree Completion of
Minority Science and Engineering Doctorate
Recipients With Traditional and Non-Traditional
Baccalaureate Origins: 1981-90

Baccalaureate Origin	Mean Age at Degree Completion	Range	SD
Traditional	32.5	23-63	3.5
Non-Traditional	34.5	29-75	4.5

Chi-square significant at .05 level

Field of Study. More recipients took their degrees in social science than in any of the four science and engineering fields. A total of 2870 (47.7 percent) of the traditional recipients majored in the social sciences. The ratio for non-traditional recipients was higher, 715 recipients or 58.6 percent of the total. In contrast, 6076 or 25.9 percent of the 23,440 science and engineering doctorate recipients in 1990 were social science majors. (National Research Council, 1991). The national ratio increases to about 30 percent when the data are limited to U.S. citizens only. (See Table 5.)

Table 5

Field of Study of Minority Science and Engineering Doctorate Recipients With Traditional and Non-Traditional Baccalaureate Origins: 1981-90

Field of Study	Traditional		Non-Traditional	
	No.	%	No.	%
Physical Sciences	961	16.0	117	9.6
Life Sciences	1610	26.8	291	23.9
Engineering	574	9.5	97	8.0
Social Sciences	2870	47.7	715	58.6
Total	6015	100.0	1220	100.0

Chi-Square significant at .05 level

Junior and Community College Attendance. Nearly 27 percent of the non-traditional recipients with responses to this item attended a junior or community college (JUCOs) and well over nine percent of the traditional students attended these schools. These are valid percents. Responses were lacking for this item for 42.5 percent of the former and 39.7 percent of the latter group. This is due to a period early on during the last ten years when the National Research Council omitted the item from its surveys and hence from its database. This finding jibes with findings regarding JUCO attendance rates in a study of all doctorate recipients for 1988-90 (N=75,560), however (Brazziel, 1992). (See Table 6.)

Table 6

Junior and Community College Attendance of
Minority Science and Engineering Doctorate
Recipients With Traditional and Non-Traditional
Baccalaureate Origins: 1981-90

Attendance Experience	Traditional			Non-Traditional		
	No.	%	V%*	No.	%	V%*
Attended JUCO	342	5.7	9.4	188	15.4	26.8
Did Not Attend JUCO	3288	54.7	90.6	514	42.1	73.2
No Response	2385	39.7	----	518	42.5	----
Total	6015	100.0	100.0	1220	100.0	100.0

Chi-Square significant at .05 level

*Valid percent = percent of subjects responding to item.
Note: NRC database does not include data for four years for this item.

Sources of Support. Minority doctorate recipients with non-traditional baccalaureate origins received less federal and university support than their traditional counterparts. Over 14 percent of the latter received support from the universities they attended and over 38 percent received support from the federal government, usually in the form of assistantships and fellowships. Non-traditional recipients received 9.2 and 25.8 percent, respectively. Significantly, this group received far less federal and university support when compared to the average doctoral recipient. In 1990, 48 percent of all doctorate recipients reported university support as their primary source of support for doctoral study. In this year, federal support was included in university support for reporting purposes. NRC officials noted that almost all federal fellowships and assistantships were administered through universities.

Over 26 percent of traditional recipients and over 40 percent of non-traditional recipients reported "other" as their primary source of support. In 1990, American citizen doctorate recipients reporting "other" as their primary source of support ranged from 2.2 percent for social science to 9.5 percent for engineering recipients. "Other" support includes nationally competitive scholarships and fellowships, e.g., Ford Foundation Scholarships, business/employer scholarships and fellowships, and support from private benefactors. (See Table 7.)

Table 7

Primary Source of Support for Graduate Study of Minority Science and Engineering Doctorate Recipients With Traditional and Non-Traditional Baccalaureate Origins: 1981-90

Source of Support	Traditional		Non-Traditional	
	No.	%	No.	%
Personal	453	7.5	82	6.7
University	863	14.3	112	9.2
Federal	2320	38.6	315	25.8
Other	1583	26.3	494	40.5
No Response	796	13.2	217	17.8
Total	6015	100.0	1220	100.0

Chi-Square significant at .05 level

Significantly, university support, including federal monies for fellowships and scholarships, for overseas nationals ranged from 55 percent for overseas national doctorate recipients in the social sciences to 85.7 percent of foreign national recipients in the physical sciences. Significant, also, is the fact that overseas national received a third or more of the doctorates awarded in the physical sciences and 56 percent of the degrees awarded in engineering.

Education of Fathers. Fathers of minority science and engineering doctorate recipients with traditional baccalaureate origins were better educated than fathers of minority science and engineering doctorate recipients with non-traditional baccalaureate origins. This, perhaps, is to be expected. To be a non-traditional student, in many instances, is to have to overcome obstacles associated with limited financial support from parents. Educated fathers make more money than fathers with modest educations. They can pay tuition. Students from homes headed by parents with limited education have to work to begin college and to complete it. As noted above, many join the armed forces to take advantage of the GI Bill. Education of fathers, more than anything else, is probably the defining factor in whether an 18 year-old will become a traditional or a non-traditional student.

Thirty-nine percent of the fathers of traditional doctorate recipients held a baccalaureate or higher degree. Consider that about 20 percent of fathers in America hold a baccalaureate. Over 14 percent of the group held a master's degree and 5.4 percent held a Ph.D. or first professional degree. On the other hand, 27 percent had not finished high school, thus indicating that a highly educated father is not entirely a sine-qua-non for production of a minority science or engineering Ph.D. If poor bright students can be afforded hope early on that they will be able to go to college and go on to a doctorate, many will do just this. The NSF Minority Initiative, more than anything else, must aim to give this hope.

Only 16 percent of the fathers of non-traditional doctorate recipients held a baccalaureate or higher degree. Only 5.8 percent held master's degrees and only 2.4 percent held the Ph.D. or a first professional degree. Fully 45 percent did not complete high school. Lots of self-made people here. (See Table 8.)

Table 8

Education of Fathers of Minority Science and Engineering Doctorate Recipients With Traditional and Non-Traditional Baccalaureate Origins: 1981-90

Level of Education	Traditional		Non-Traditional	
	No.	%	No.	%
Less Than High School	1244	20.7	471	38.6
High School 9,10,11	401	6.7	84	6.9
High School 12	1305	21.7	257	21.1
College 1,2,3	693	11.5	94	7.7
College 4	835	13.9	99	8.1
Master's & Professional	850	14.1	71	5.8
Ph.D. and Postdoctoral	323	5.4	29	2.4
No Response	364	6.1	115	9.4
Total	6015	100.0	1220	100.0

Chi-Square significant at .05 level

Education of Mothers. As with fathers, mothers of minority science and engineering doctorate recipients with traditional baccalaureate backgrounds were better educated than mothers of minority science and engineering doctorate recipients with non-traditional baccalaureate backgrounds. Twenty-six percent held a baccalaureate or higher degree. Ten percent held a master's and 1.4 percent held a Ph.D. or first professional degree. Again, high educational levels of mothers is not a sine-qua-non for science and engineering doctoral production among minority students. Nearly 26 percent of the mothers had not finished high school.

Only 9.3 percent of the mothers of minority science and engineering doctorate recipients in this study held a baccalaureate or higher degree. Only 3.3 percent held a master's degree and less than one percent held a Ph.D. or first professional degree. Forty-seven percent of the mothers in this group had not finished high school.

Table 9

Education of Mothers of Minority Science and Engineering
Doctorate Recipients With Traditional and Non-Traditional
Baccalaureate Origins: 1981-90

Level of Education	Traditional		Non-Traditional	
	No.	%	No.	%
Less than High School	1120	18.6	461	37.8
High School 9,10,11	430	7.1	105	8.6
High School 12	1619	26.9	302	24.8
College 1,2,3	876	14.6	119	9.8
College 4	847	14.1	71	5.8
Master's & Professional	626	10.4	40	3.3
Ph.D. & Postdoctoral	104	1.7	3	.2
No Response	393	6.5	119	9.2
Total	6015	100.0	1220	100.0

Chi-Square significant at .05 level

Elapsed Time to Degree

Minority science and engineering doctorate recipients with non-traditional baccalaureate origins took the same number of years as their traditional counterparts to earn their Ph.D. degrees. The former completed their Ph.D. in 10.6 years after completing their baccalaureates while the latter took 10.6 years to complete their degrees. Once past the baccalaureate, things even out for the groups, it seems (See Table 10.)

Table 10

Elapsed Time to Degree of Minority Science and Engineering Doctorate Recipients With Traditional and Non-Traditional Baccalaureate Origins: 1981-90

Range in Years	Traditional		Non-Traditional	
	No.	%	No.	%
< 3			2	.2
3 - 5	671	11.2	120	9.8
6 - 8	1970	32.7	360	29.5
9 - 11	1380	22.9	327	26.8
12 - 14	878	14.6	188	15.4
15 and Over	1116	18.6	223	18.3

Mean Years:

Traditional = 10.6 SD = 5.4

Non-Traditional = 10.6 SD = 5.1

Chi-Square significant at .05 level

Significantly, both groups took more time to complete degrees than did the average doctoral students. Science and engineering doctorate recipients for 1990 took 8.7 years after their baccalaureates to complete the degree. Significantly, social science doctorate recipients for 1990 took 10.6 years (National Research Council), as did recipients in this study. Recall, too, that 58 percent of the recipients in this study took degrees in the social sciences.

Registered Time to Degree

There was virtually no difference in the amount of registered time to the doctorate for minority science and engineering doctorate recipients with traditional baccalaureate origins and minority science and engineering doctorate recipients with non-traditional baccalaureate origins. Mean registered years for the former was 7.3; for the latter: 7.4. (See Table 11.)

Table 11

Registered Time to Degree of Minority Science and Engineering Doctorate Recipients With Traditional and Non-Traditional Baccalaureate Origins: 1981-90

Range in Years	Traditional		Non-Traditional	
	No.	%	No.	%
< 3	8	.1	3	.2
3 - 5	1425	23.5	291	23.9
6 - 8	2634	43.8	507	41.6
9 - 11	1074	17.9	207	17.0
12 - 14	295	4.9	55	4.5
15 and Over	110	1.8	33	2.7
No Response	479	8.0	124	10.2

Mean Years:

Traditional = 7.3 SD = 2.7

Non-Traditional = 7.4 SD = 2.8

Chi-Square significant at .05 level

Registered time to degree for 1990 doctorate science and engineering recipients was 6.5 years; for social science recipients: 7.5 years (National Research Council, 1991). Recall that 58 percent of the recipients in this study received social science doctorates.

Elapsed Time to Degree by Field of Study

Historically, physical science doctorate recipients have led all doctorate recipients in the rapidity with which they complete their degrees. In 1990, for example, these recipients received their doctorates 7.6 years after receiving their baccalaureates. They were followed by engineering recipients at 8.2 years, life science recipients at 9.1 years and social science recipients at 10.6 years (National Research Council, 1991).

Table 12

Elapsed Time to Degree by Field of Study of
Minority Science and Engineering Doctorate
Recipients With Traditional and Non-Traditional
Baccalaureate Origins: 1981-90

Field of Study	Traditional		Non-Traditional	
	Mean Years	SD	Mean Years	SD
Physical Sciences	8.83	4.59	8.86	4.94
Engineering	9.33	4.65	11.09	5.43
Life Sciences	10.45	5.25	10.04	4.36
Social Sciences	11.49	5.58	11.07	5.20
Total	10.58	5.35	10.61	5.05

Minority science and engineering doctorate recipients in this sample exhibited the same patterns. Recipients of physical science doctorates with traditional baccalaureate origins completed their degrees in 8.8 years. They were followed by engineering recipients who required 9.3 years and life science and social science recipients who required 10.4 and 11.4 years respectively. For recipients with non-traditional baccalaureate origins, the patterns were dissimilar for engineering where recipients required 11.0 years to complete their degrees, two years longer than required for recipients with traditional baccalaureate origins. (See Table 12.)

Registered Time to Degree by Field of Study

Engineering doctorate recipients move to the fore in registered time to degree by field of study, requiring only 6.0 years of registered time in 1990 for degree completion. They were followed by physical science recipients at 6.2 years and life sciences and social sciences with 6.7 and 7.5 years respectively (National Research Council, 1991). Minority science and engineering doctorate recipients in this study followed the same pattern. (See Table 13.)

Table 13

Registered Time to Degree by Field of Study of Minority Science and Engineering Doctorate Recipients With Traditional and Non-Traditional Baccalaureate Origins: 1981-90

Field of Study	Traditional		Non-Traditional	
	Mean Years	SD	Mean Years	SD
Physical Sciences	6.90	2.64	6.69	2.65
Engineering	6.46	2.51	6.98	2.68
Life Sciences	6.96	2.37	6.45	1.97
Social Sciences	7.90	2.77	7.97	3.01
Total	7.34	2.67	7.39	2.84

Recipients with traditional baccalaureate origins required 6.4 years of registered time for completion. They were followed by physical science recipients with 6.9 years and life science and social science recipients with 6.96 and 7.90 years respectively. Significantly, recipients with non-traditional baccalaureate origins matched their traditional counterparts, for the most part, in registered time to degree. Life and physical science recipients led the way here, however, requiring 6.4 and 6.6 years of registration time to complete their degrees. They were followed by engineering and social science recipients who required 6.9 and 7.9 years of registered time, respectively, to complete their degrees.

Analysis of Variance: Elapsed Time to Degree by Field of Study of Recipients with Traditional Baccalaureate Origins

Data for elapsed time to degree were subjected to analysis of variance to ascertain the degree of significance of differences among the fields of study. As shown in Table 14, the F value of 75.19 is highly significant.

Table 14

Analysis of Variance: Elapsed Time to Degree by Field of Study of Minority Science and Engineering Doctorate Recipients With Traditional Baccalaureate Origins: 1981-90

Source of Variance	DF	Sum of Squares	MSS	F
Between Groups	3	6230	2077	75.19*
Within Groups	6011	166009	28	
Total	6014	172239		

*Significant at .01 level

Scheffe A Posteriori Test: Elapsed Time ANOVA for Traditional Recipients. As can be noted from the Scheffe test in Table 15, the highly significant F value for the analysis of variance exercise derives from differences among five of the six possible pairings of the fields. The pairing of engineering and physical sciences yielded no significant differences in elapsed time to degree. (See table 15.)

Table 15

Scheffe A Posteriori Test of ANOVA Exercise for
Elapsed Time to Degree by Field of Study of Minority
Science and Engineering Doctorate Recipients With Traditional
Baccalaureate Origins: 1981-90

Field	Social Sciences	Life Sciences	Engineering	Physical Sciences
Social Sciences		*	*	*
Life Sciences			*	*
Engineering				
Physical Sciences				

Analysis of Variance: Elapsed Time to Degree by Field of Study of Recipients with Non-Traditional Baccalaureate Origins

Data for elapsed time to degree were subjected to analysis of variance to ascertain the degree of significance of differences among the fields of study. Recall that mean elapsed time to degree for the subjects in this group ranged from 8.8 years for physical science recipients to 11.0 years for social science recipients. As shown in Table 16 the F value of 8.32 for this exercise is highly significant.

Again, it can be recalled that the order of elapsed time to degree by field of study for this sample jibes, for the most part, with elapsed time to degree for national samples. (See Table 16.)

Table 16

Analysis of Variance: Elapsed Time to Degree by Field
of Study of Minority Science and Engineering
Doctorate Recipients With Non-Traditional
Baccalaureate Origins: 1981-90

Source of Variance	DF	Sum of Squares	MSS	F
Between Groups	3	626	209	8.32*
Within Groups	1216	30489	25	
Total	1219	31115		

*Significant at the .01 level

Scheffe A Posteriori Test for ANOVA of Non-Traditional Recipients. As can be noted from the Scheffe results in Table 17, the highly significant F value for differences according to field of study recorded in Table 15 derived from differences in three of the six possible pairings of the fields: social x life sciences, social x physical sciences and engineering x physical sciences.

Table 17

Scheffe *A Posteriori* Test of ANOVA Exercise for
Elapsed Time to Degree by Field of Study of Minority
Science and Engineering Doctorate Recipients With Non-Traditional
Baccalaureate Origins: 1981-90

Field	Social Sciences	Life Sciences	Engineering	Physical Sciences
Social Sciences		*		*
Life Sciences				
Engineering				*
Physical Sciences				

Predictors of Elapsed Time to Degree: Recipients with Traditional Baccalaureate Origins

All of the demographic and educational variables were tested for power to predict elapsed time to degree of minority science and engineering doctorate recipients with traditional baccalaureate origins. Stepwise multiple regression analysis was the statistical procedure employed in this exercise. Seven variables emerged as significant predictors: primary source of support, father's education, field of study, race, sex, mother's education and attendance at junior or community college. The seven accounted for 12 percent of the variance in the sample. This would comprise a modest amount of explained variance for closely related phenomena, e.g., IQ and reading test scores but it comprises a significant amount for something as individual as people completing a doctorate. (See Table 18.)

Table 18

Predictors of Elapsed Time to Degree of
Minority Science and Engineering Doctorate
Recipients With Traditional Baccalaureate Origins: 1981-90

Predictor Variables	R	R^2	Beta	F
Primary Source of Support	.201	.040	.201	119.3
Father's Education	.263	.069	-.170	105.5
Field of Study	.300	.090	-.147	93.7
Race	.324	.104	-.122	83.0
Sex	.336	.113	.094	73.4
Mother's Education	.344	.118	-.093	63.4
JUCO Attendance	.346	.120	.038	55.1

Significantly, the first three variables: support, father's education and field of study accounted for the lion's share of the variance accounted for. All three have to do with money. Father's education, while not a primary source of support for all recipients, was surely a primary source of support for many, and a source of supplementary and emergency support for many. Recall that the higher the father's education the larger the father's income and the more he is able to help his children. Field of study can be considered a surrogate for source of support. For example, students in the physical sciences and engineering finish earlier than most. Students in the physical sciences and engineering also receive more in the way of federally funded teaching and research assistantships on campuses.

Predictors of Elapsed Time to Degree of Minority Science and Engineering Recipients with Non-Traditional Baccalaureate Origins

All of the demographic and educational variables were tested as predictors of elapsed time to degree for subjects in the study with non-traditional baccalaureate origins. Stepwise multiple regression analysis was the statistical procedure employed in this exercise. Two variables emerged as significant predictors: primary source of support and attendance at a junior or community college. Five percent of the variance in the sample was accounted for, again, doctoral completion is a highly individual endeavor. (See Table 19.)

Table 19
Predictors of Elapsed Time to Degree of
Minority Science and Engineering Doctorate
Recipients With Non-Traditional Baccalaureate Origins: 1981-90

Predictor Variables	R	R^2	Beta	F
Primary Source of Support	.185	.034	.185	16.2
JUCO Attendance	.224	.050	.126	11.9

Predictors of Elapsed Time to Degree by Field of Study: Recipients with Traditional Baccalaureate Origins

All of the demographic and educational variables were tested as predictors of elapsed time to degree by field of study of minority doctorate recipients with traditional baccalaureate origins. Five variables emerged as predictors of elapsed time to degree of life science degree recipients: father's education, primary source of support, sex, race and mother's education. Ten percent of the variance was accounted for by these variables. (See Table 20.)

Table 20

Predictors of Elapsed Time to Degree by Field of Study of Minority Science and Engineering Doctorate Recipients With Traditional Baccalaureate Origins: 1981-90

Predictors by Field of Study	R^2
Physical Sciences	
Father's Education	.051
Sex	.067
Engineering	
Mother's Education	.026
Primary Source of Support	.049
Life Sciences	
Father's Education	.039
Primary Source of Support	.067
Sex	.093
Race	.096
Mother's Education	.100
Social Sciences	
Primary Source of Support	.053
Race	.071
Mother's Education	.089
Sex	.094

Predictors of Elapsed Time to Degree by Field of Study: Recipients with Non-Traditional Baccalaureate Origins

No variables entered the prediction equation when regression exercises were carried out to test possible predictors of elapsed time to degree for minority doctorate recipients in engineering and physical science. As noted above, completing a Ph.D. in science and engineering is a challenge of the first order and the reasons for success or failure are vagarious. A single variable, sex, accounted for eight percent of the variance for life science recipients. This no doubt reflects the presence of sizable numbers of women in the health sciences in this field, many of whom combined family, career and doctoral study. A single variable: primary source of support accounted for five percent of the variance for the social sciences, surely reflecting the handful of individuals who received fellowships and assistantships. (See Table 21.)

Table 21

Predictors of Elapsed Time to Degree by Field of Study of Minority Science and Engineering Doctorate Recipients With Non-Traditional Baccalaureate Origins: 1981-90

Predictors by Field of Study	R^2
Physical Sciences	
No variables entered equation	
Engineering	
No variables entered equation	
Life Sciences	
Sex	.08
Social Sciences	
Primary Source of Support	.05

Again, studying for and completing a Ph.D. is a highly individual endeavor. Fortitude, courage and a certain amount of luck are terms and concepts which come to mind when the subject is discussed. Supplementing regression exercises with individual interviews with minority science and engineering doctorate recipients can corroborate indicators of enabling factors such as primary source of support and secondary sources of support such as father's education and field of study. More important, interviews can get at aspects of doctoral study which simply do not lend themselves to surveys and statistical analyses, e.g., the uncertainty attached to study for the degree, finding an adviser, finding a committee whose members are **compatible with each other**, selecting a doable research project, dealing with life events such as death, divorce, broken relationships, illnesses and more.

Interviews of this nature comprised the second half of our study. Again, interviews were conducted with minority doctorate recipients with traditional baccalaureate origins and insights gained from these interviews were juxtaposed with insights gained from interviews with minority doctorate recipients with non-traditional baccalaureate backgrounds. Further,insights gained from both sets of interviews and from the statistical analyses were used to interview possible minority doctoral prospects from two non-traditional sources: the military and the corporate world. Reports from these interviews follow.

FINDINGS: INTERVIEWS WITH MINORITY SCIENCE AND ENGINEERING DOCTORATE RECIPIENTS WITH TRADITIONAL BACCALAUREATE ORIGINS

We interviewed twelve minority doctorate recipients with traditional baccalaureate origins to corroborate insights gained from the statistical analyses developed in the first section of this report. More important, perhaps, we attempted to get at key aspects of doctoral study in science and engineering by members of minority groups in America. We engaged each interviewee in a guided conversation which lasted up to a full hour. We began with questions about home and family, and about baccalaureate and master's institutions. We discussed their present jobs and their satisfactions with these jobs. We then tried to get at enabling factors in their doctoral study by having them discuss challenges they faced in completing their degrees and how they overcame these challenges. We then asked them to advise both universities and the National Science Foundation on how best to assure success for NSF's Minority Initiative. Summaries of each interview can be found in Appendix A. The interview schedule for this group can also be found in Appendix A.

About the Interviewees

We interviewed a president and a chief operating officer of an electrical engineering consulting firm in the Washington, DC metropolitan area. This was a husband and wife team. Both were truly brilliant people: baccalaureates from MIT and Ph.D.s from Stanford in electrical engineering. Elapsed time from baccalaureate to doctorate: seven years.

We interviewed a technical staff person from the Washington office of the Rand Corporation. Another very brilliant person: MIT baccalaureate, Stanford Ph.D. Elapsed time to degree, six years. Field of study: physics.

We interviewed a young woman who began her college career at a black college in a small town in Georgia. She completed her Ph.D. in pharmacology at a black university in Florida. She is now serving as a research analyst at the 3M Corporation of Minneapolis, MN.

We interviewed a young woman who began her college career at a regional state university in Georgia and completed her Ph.D. at Florida State University. Major field: mathematics. Present job: mathematics education professor at another

Florida state university.

We interviewed a research fellow at the University of Kansas Medical Center. He took all of his degrees in pharmacology at a black university in Florida.

We interviewed the director of the Puerto Rican Cultural Center at the University of Connecticut. This young man took master's and Ph.D. degrees in anthropology from Stanford after graduating with an anthropology degree at the University of Connecticut.

We interviewed a high school principal who came to Connecticut after high school in Puerto Rico and who completed all of her degrees in psychology at the University of Connecticut.

We interviewed a husband-wife team of research engineers from the Bell Communications Corporation of Red bank, NJ. These young people completed their Ph.D.s at the University of Florida, only five years after completing their baccalaureates at the nation's second largest black university. Their field: electrical engineering.

We interviewed a young lady who is a research physicist at the City of Hope National Medical Center in Duarte, CA. Brilliant. She completed a nuclear engineering degree at the University of Virginia at age 21. She completed her nuclear engineering Ph.D. degree at the University of Florida five years later.

We interviewed an assistant professor of psychology at Miami University of Ohio who began her college career at a regional state university in Alabama. She completed a developmental psychology degree at the University of Florida seven years later.

Most Challenging Doctoral Experiences

The doctoral experience is a challenge of the first order. To get at enabling forces in the doctoral process for our subjects, we asked early on in the interviews about the three most challenging experiences interviewees encountered in their doctoral programs, about the strategies they used to deal with these challenges and about the people who help them do this.

Predictably, finding money to study for the doctorate led the list of most challenging experiences of the doctoral study of the recipients.

Finding a good adviser was a close second. This is a common challenge among doctoral students everywhere, it seems. Some advisers have a reputation of getting people through the program. Others have the opposite reputations. Young advisers are apt to leave for greener pastures. Others may not make tenure. Older advisers may retire. Or die. Without a doubt, getting a "good" adviser is the single most important thing a doctoral student can do. Any doctoral student.

Getting a compatible committee was mentioned next most often by the interviewees. People close to doctoral study are familiar with the havoc an incompatible committee can wreak. These people engage in vendettas, some 20-30 years old. The loser, of course, is the student. Next to getting a good adviser, getting a good committee is the best thing that can happen to a doctoral student.

Many of the challenges we discussed were unique. TS-10 (Traditional Student 10), for example, had difficulty getting the university to buy the equipment needed for his dissertation research. He finally arranged for a corporation to give the university the money to buy the equipment. TS-3 recalled the hopeless feeling she experienced when her experiment did not work. She almost did not start again. Long telephone discussions with a mentor 400 miles away helped her get through this and start again, however. Mentors were mentioned more than once or twice in the interviews. They are enabling factors in the truest sense.

TS-6 had found arranging to go back to school after four years as a housewife and mother very challenging. TS-8 found it very hard to leave a job, take a 60 percent cut in income and go back to school.

TS-12 found things very overwhelming and herself very lonely until she found a mentor on her own, an experienced black professor who helped her learn the ropes. Indeed, a person who actually did research with her. The mentor told her that most black science and engineering students were remarkable in that they were passing their courses and doing their research without the benefit of the all-important study groups. Super-students. In many cases they were the only black students in their programs and many were simply not invited to join study groups.

TS-11 reported one of the few blatant racist situations. A professor in her department simply felt that black women had no place in nuclear engineering and made a determined effort to make her quit the program. This individual engaged in crude attempts at psychological harassment, according to TS-11. It was totally ineffective, but annoying. She noted that she had experienced no difficulty at all at the University of Virginia and was thus surprised that something like this would crop up at the University of Florida. Talks with an associate dean of the Graduate School, himself a black person, helped her "hang in."

Others reported having to brace for outbreaks of racism on campus by right-wing students, but noted that these outbreaks were short-lived. All-in-all, blatant racism was not a universal problem.

Several recipients mentioned money problems with no one to help out with contingency loans and the like. Settling on a doable research topic and getting it approved was a predictable topic of conversation. So was getting into the "right" research group.

Many of the challenges in these interviews were topics the average doctoral recipient would discuss if asked to reflect on their doctoral experiences. Some were not. The woman who reported on the racist professor is not the usual doctoral program challenge, of course. The frequent mention of mentors and helpful people on campus indicates a strong source of enablement. The challenge to doctorate students can be daunting. "Just being the only black woman in the department was a challenge," one woman said, "and it is there, every day, all day," she continued.

We concluded from the interviews that minority science and engineering doctoral students have many of the same problems as white science and engineering doctoral students, but that they are compounded by their minority status, and that on occasion they can be career-threatening. Finding a "good" adviser is a problem for all students, for example, it is compounded for minority students by the fact that many "good" advisers may not want to work with minority students. Allusions to this reluctance cropped up in several interviews. We concluded that problems of minority students need attention from their department and from an effective minority assistant or associate dean of graduate education.

Advice to NSF on The Minority Initiative

We asked the interviewees to suggest advice NSF might find useful as it gears up for its Minority Initiative. Predictably, adequate funding - MONEY - led the list of most-mentioned advice. The recipients felt that replication of programs like the McKnight Foundation Program of Florida will be necessary to effect any meaningful change in the numbers of minorities receiving doctorates in science and engineering. Their reasoning for this conclusion is flawless. As things now stand, several noted, much of the federal money flowing to campuses to hire research assistants goes to foreign students. These students work on federally funded research projects, many funded by NSF. Most are excellent research assistants, the best their countries have to offer. Professors, for their part, are looking for world-class help on their research projects. Minority students simply are not included in this loop. Further, most faculties at research universities are not yet ready to hire significant numbers of minorities as teaching assistants. These jobs will continue to go to white graduate students, for the most part. Therefore, direct grants for fellowships and scholarships are the only viable options left. "Clone McKnight," an interviewee advised, "don't waste your time trying to come up with anything else." She may be right.

Almost to a person, the interviewees urged NSF to mount a broad program to involve minority children and youth in science and engineering experiences which will attract them to a life in these fields. "After junior high school, it is difficult, if not impossible, to attract a young person to science," an interviewee noted. Science camps, summer institutes, world-class labs in magnet schools and community colleges in the neighborhood, shadowing opportunities in corporate and university labs, summer institutes on college campuses, and minority role models visiting local science and engineering clubs were just a few of the suggestions interviewees would like to have considered.

Advice to Universities on The Minority Initiative

Almost to a person the recipients urge universities to try to improve the process of getting a "good advisor and advisory committee." As noted above, several noted that some advisers seemed hesitant to take on minority advisees. This problem can be solved, they noted, by department chairs and deans who accord stature to those who take on these students. These leaders must talk forthrightly about the necessity for America to train and utilize minority talent in science and engineering if our country is to have any chance at all of competing successfully in global markets.

Almost to a person, the recipients urge universities to hire minority faculty to the extent possible. "It is reassuring to have these people around, although you may never have an intellectual exchange with them," TS-3 noted. Minority faculty serve as role models of course, but they also serve as an affirmation of sincere commitment on the part of the university to developing minority talent. This is reassuring to minority students, it seems. Significantly, the recipients urged universities to move past tokenism and hire several minority professors for a given department or program.

A physics professor (TS-9) urged universities to try to promote a better understanding of the many job opportunities for physicists. This should begin in the elementary schools, he noted. Few people realize what physicists really do in real life, he said. Most perceptions have been formed by Star Wars-type television, he noted.

TS-1 urges cluster recruiting to lessen the "terrible isolation" of many minority students in programs. A computer science major, TS-1 noted that he had been the sole black person in his program for the 10 years or so it took him to go from the freshman year to the Ph.D. and that things would have been better if more blacks had made the journey with him.

TS-4 wants universities to make sure minority students "tap into the network" by supporting travel to conferences, encouraging white students to invite them to join study groups and the like. TS-4 also noted that many universities erroneously expect Asian and Indian professors to serve as role models for black students. This is simply won't work, the recipient noted, and it lessens confidence in the university's commitment to The Minority Initiative.

TS-7 urges universities to recruit high B+ minority students instead of looking for high A- or A people. He noted that most of the white students in his program were high B+ while most of the black students were high A- or A. He notes that A and A- minus students are rare, regardless of race, and that we are just "spinning our wheels" unless this attitude changes and recruitment and admissions policies and practices are broadened.

TS-8 suggested that universities recruit at Puerto Rican as well as American universities. He began his baccalaureate at a university in Puerto Rico and completed it at a mainland university. He doubts seriously that he would have made it into a Ph.D. program if he had not come to the mainland. Many people regard Puerto Rico as a foreign country instead of an American commonwealth, he said.

TS-9, a high school principal and also a transplanted Puerto Rican suggests workshops on cross-cultural teaching for interested professors. She also wants "recognition in all of the little ways" to be accorded advisers who work with minority students.

TS-10, a research engineer for Bell Communications, urges universities to develop a cadre of mentors among minority corporate and government professionals all across the country. She also suggests heavy use of alumni as mentors.

TS-11 urges a strong minority assistant or associate dean in every graduate school. It is only through this sort of representation can The Minority Initiative advance, she noted. The myriad federal and foundation programs to assist minorities require applications and paper work the graduate school without such a person will fail to process. The Minority Initiative itself requires a tremendous amount of explaining to professors and others. Further, when things go bad for whatever reason, minority students need someone who understands to turn to.

TS-12 wants universities to reach out to community-based groups attempting to develop science and engineering talent among youngsters and to work with them in as many creative ways as possible.

FINDINGS: INTERVIEWS WITH MINORITY SCIENCE AND ENGINEERING DOCTORATE RECIPIENTS WITH NON-TRADITIONAL BACCALAUREATE ORIGINS

Interviews with minority science and engineering doctorate recipients with non-traditional baccalaureate origins followed the same pattern described above for recipients with traditional baccalaureate origins. The same interview schedule was use in order to enhance juxtaposition of derived insights. Again, we began with conversation about home and family and undergraduate institutions and career pursuits. We then moved into challenges of the doctoral program and how they were overcome. We ended with solicitations of advice to NSF and to institutions working with minority students on how best to assure success for The Minority Initiative in science and engineering.

About the Interviewees

We interviewed ten minority science and engineering doctoral recipients with baccalaureate origins as non-traditional students. The defining factor here was that these individuals completed their baccalaureates at age 25 and older.

The recipients had a remarkable range of experiences. We interviewed the president of a health marketing systems corporation in the metropolitan Washington area who completed his baccalaureate in health services and cybernetics at age 25 and his doctorate at age 34. His source of support was himself and his wife. He had to work two years to save enough money to even begin the baccalaureate.

Summaries of interviews with minority science and engineering doctorate recipients with non-traditional baccalaureate origins can be found in Appendix

B along with the interview schedule.

We interviewed an assistant professor of communications sciences at a large regional state university in Virginia. He began his college career at one of America's most prestigious black universities (Hampton University), completed a master's degree at Syracuse and his Ph.D. at the University of Florida. He completed his degree at age 36. He worked for three years to save money to begin college and finished his baccalaureate at age 25.

We interviewed an assistant professor of biology at a black state university in Alabama who completed a baccalaureate at the University of Alabama and a master's degree at the school in which he teaches. He too had to work to begin his college career and he finished his baccalaureate at age 26.

We interviewed another delayed entrance individual who completed a baccalaureate in chemistry at age 25 at the University of Central Florida. He completed a Ph.D. in five years after the baccalaureate, however, and was on the job as a research chemist at Royhaym Haas of Springhouse, PA by age 30. Reason for delayed entry to college: poverty.

We interviewed an associate vice president for academic affairs at one of America's better black liberal arts colleges who completed her baccalaureate at age 28 and her doctorate at age 55. She married in her sophomore year in college and followed her husband to another state where she enrolled in another institution and completed her degree, after settling into her new home and working as a file clerk for a couple of years. Her major: counseling psychology.

We interviewed a U.S. Army veteran who completed his baccalaureate at a black college in Florida at age 30 and his Ph.D. at Florida A&M University at age 40. He is presently working as an environmental toxicologist at the U.S. Center for Disease Control.

We interviewed a veteran of the U.S. Air Force who completed a physics baccalaureate at Pennsylvania State University at age 25 and a Ph.D. in physics at Penn State four years later. Significantly, he began his college career in a two-year branch of his university. Significantly, too, he received support from the G.I. Bill for baccalaureate study and from the National Science Foundation for doctoral study. As a result, his elapsed time to the doctorate was the lowest of all interviewees (four years) and among the lowest for any recipients in the statistical sample. He is presently a professor of physics at the University of Connecticut.

We interviewed a school principal who completed a Ph.D. in psychology at the University of Connecticut after beginning her career at a two-year college in Puerto Rico and completing a baccalaureate at the University of Puerto Rico at age 29. In between came marriage and family. She completed her Ph.D. at age 41.

We interviewed an assistant professor of computer engineering at the University of Central Florida who worked hard to begin and finally complete a baccalaureate at the College of the Virgin Islands at age 33. He completed his doctorate at Central Florida in six years, however, and began his present job at age 39.

We interviewed the husband of the husband and wife team of research engineers mentioned earlier (Bell Communications). This individual worked his way through America's second largest black university (Southern University), dropping out for a year to keep from taking out loans. He completed his baccalaureate at age 25 and moved swiftly through the doctoral program in electrical engineering at the University of South Florida. He received his degree at age 30.

All-in-all we interviewed some remarkable people. People with non-traditional baccalaureate origins usually are and all have a remarkable story to tell.

Most Challenging Experiences

When juxtaposed with the most challenging experiences mentioned by recipients with traditional baccalaureate origins, many, if not most, of the same challenges emerge. NTS-10 (Non-Traditional Student Doctorate Recipient), for example, had trouble getting an adviser to work with him. So did his wife, a doctorate recipient with traditional baccalaureate origins. His wife specified "good" adviser, however, as did most of those who mentioned this matter. Getting a good adviser and a good committee was second only to money on the list of challenges mentioned most often by recipients with both traditional and non-traditional baccalaureate origins.

Recipients with non-traditional baccalaureate origins mentioned financial straits more often that their traditional counterparts. More were older, more were married and more had children.

Giving up a secure job and taking a loss in income was a problem for NTS-2 who left a college teaching job to go back to school. He did this with his first child to be born soon.

Adjusting to the role of student again was a challenge to NTS-2 and an even greater challenge to NTS-5 who returned to school to complete her Ph.D. in her early 50s. She noted with gritty determination in her voice that "I had to grovel, and it hurt. But I did it."

Like doctoral students everywhere, the recipients mentioned affairs of the dissertation: selecting a doable topic, getting the study done and defending it. Getting the qualifying or general exams out of the way was a challenge for one or two.

No blatant racist situations developed for any of the recipients with non-traditional baccalaureate origins as it did for one of their traditional counterparts. Keeping perspective in the face of demonstrations and racist rhetoric of something called the White Student Union was mentioned, however. Also mentioned was keeping perspective in the face of racist rhetoric by a graduate school dean which somehow became public.

Advice to NSF on The Minority Initiative

Like their traditional counterparts, minority doctorate recipients with non-traditional baccalaureate origins urge NSF to use every creative outlet possible to reach elementary and junior high school children and bring them into the science and engineering community. Like their counterparts, they fairly shout that waiting until high school is much too late. NTS-5 wants kindergarten science camps and science oriented day-care centers.

Like their traditional counterparts, the non-traditional group wants a steady procession of minority role models from corporations and university faculties before the children.

NTS-6 wants NSF to promote university and government partnerships which enable minority students at all levels to shadow professionals and, at the doctoral level, to complete internships and practica in agencies.

NTS-9 wants NSF to promote the idea of moving from school to school in a search for dissertation topics and, importantly, dissertation advisers.

Again, many of the interviewees had completed their degrees with grants from the McKnight Foundation. Almost to a person, they urged NSF to "clone McKnight."

Advice to Universities on The Minority Initiative

Like their traditional counterparts, recipients with non-traditional baccalaureate origins urge universities to reach out early to young people and involve them in science and engineering.

Like their counterparts, the NTS recipients want the universities to reward good advisers in every way possible and to bring some sort of guarantee to doctoral students that **someone will be their adviser and that they will not have to grovel to get an adviser**. We have seen this situation develop on a number of occasions. It is not pretty. Further, the uncertainty surrounding difficulty in finding an adviser can be career-threatening. Some students drop out of Ph.D. programs because of this uncertainty. NTS-9 advanced the most creative idea on the problem of advisers: allow students to take on advisers from other universities, or even in corporations or government agencies, to complete their dissertations.

This group also wants minority assistant and associate deans in graduate school offices. And they want a contingency fund for students who simply run out of money.

They too want minority role models - in some numbers - in departments and programs. Important and different, NTS-2 urges colleges and universities to recruit and enroll 30-35 year-old doctoral students. He noted that many science and engineering departments don't like doctoral starts this old. He notes, and rightly so, that older students will be the majority of college students in four or five years and that people with doctorates now routinely work until they are in their seventies. Clinging to the notion that the mid-twenties are the best doctoral start years is a grave error, he noted.

NTS-3 sees a lot of whimsy and mismanagement in doctoral programs. Others see this too and they have begun to talk out loud about the matter, it seems. To quote NTS-3: "Develop more structure to the Ph.D. program, e.g., state clearly what is required, write it down and give it to the students."

NTS-4 and others want a critical mass of minority graduate students as opposed to the proverbial "one token at a time." He also wants minority graduate students paired, for the most part, with experienced advisers, people who have brought through three or four candidates.

The oldest doctorate recipient in the groups (NTS-5) suggests that universities ask churches in the community to reach out to their graduate students and thus provide relaxation from the "campus grind." Friends and confidantes are also made in this process, she noted.

The physics professor in the groups (NTS-7) urges universities to encourage study groups among minority students and to the extent possible among white and minority students.

The Puerto Rican school principal in the group (NTS-8) urges provision of "language polishing" centers for bilingual minorities who must make their way in an English speaking society. She notes that polished diction and enhanced vocabularies will mean a lot in terms of career advancement for many minority graduates.

FINDINGS: INTERVIEWS WITH PROSPECTIVE MINORITY DOCTORAL STARTS - CORPORATE SCIENCE AND ENGINEERING PROFESSIONALS

Eleven interviews were conducted with minority corporate science and engineering professional workers. As noted earlier, this may be a fine source of minority doctoral starts. They are capable people and many have completed courses in corporate training programs which would serve them well in doctoral study.

We began our interviews with corporate professionals with the same conversations about jobs, families and undergraduate education that characterized our interviews with doctorate recipients. We then broached the subject of returning to school to study for the Ph.D. degree in science or engineering. In the ensuing discussion, we tried to identify what it would take in the way of financial support and university organization and support to have them do such a thing. This led into general suggestions by the interviewees on how best NSF could assure success of its Minority Initiative. We also discussed corporate or other courses the interviewees had taken which might be helpful in their quest for a Ph.D. degree. Our interviews ended with a question on whether the interview itself had piqued their interest in going back to school and a question on whether the interviewee would like to have his/her name shared with people involved in the Minority Initiative to increase minority science and engineering doctorates. Summaries of interviews with minority science and engineering doctorate prospects from the corporate sector can be found in Appendix C.

About The Interviewees

We interviewed a biologist with the Monsanto Corporation of St. Louis who was 12 years away from his baccalaureate and married. He received his baccalaureate from the University of Missouri-St. Louis. He has often thought of pursuing a Ph.D.

We interviewed an electrical engineer with IBM's St. Louis operations. He received his baccalaureate from the University of Missouri-St. Louis. He too was married and has given serious thought to studying for the Ph.D. He is only a year away from his baccalaureate.

We interviewed a nuclear engineer with the Greater St. Louis utilities corporation: Union Electric. He is only a year away from the baccalaureate and has given serious thought to returning to school for a doctorate in engineering. He is single.

We interviewed an analytical biochemist from the Sigma Chemical Corporation of St. Louis. He is divorced, one year away from his baccalaureate (i.e., completed his baccalaureate within the last year) and has given some thought to returning to school for graduate work.

We interviewed a pharmaceutical chemist with Pharmaceutical Systems-St. Louis. She is married and five years away from the baccalaureate. She dismissed the idea of returning for the doctoral study out of hand: "No way." She noted that there was no incentive. Her salary was not likely to increase. She then went on to describe stipend levels which would enable her to return and to offer advice to NSF on effecting a successful Minority Initiative.

We interviewed a process engineer with the Mallinckrodt Corporation of St. Louis, manufacturers of scientific instruments. She was single, 10 years away from her baccalaureate in chemical engineering and said that getting a Ph.D. was definitely in her life plans.

We interviewed a medical student and part-time paramedic who was two years away from his baccalaureate. He has never thought of pursuing a Ph.D. He plans to be a physician.

We interviewed a young quality control technician with Becks Flavors Ice Cream Company of St. Louis. She is three years away from her baccalaureate and married. She has definite plans for pursuing a doctorate in her field: biology.

We interviewed an environmental biologist with the Eagle-Pitcher Corporation of St. Louis. She is single, four years away from her baccalaureate and has definite plans to pursue a Ph.D. degree.

We interviewed a housewife who is one year away from her chemistry baccalaureate and who has plans to pursue a Ph.D. degree.

Biggest Challenge to Pursuit of a Ph.D.

We sought to identify the deterrents to efforts to attract young minorities in corporate positions to classrooms and laboratories as doctoral students. We challenges involved.

Predictably, the biggest challenge young people in this group face in leaving the corporate world for the campus and the pursuit of a Ph.D. is money. Generally, the lower the elapsed time between baccalaureate and job entry of young minority corporate professionals, the firmer the resolve for returning for doctoral study. Being single or divorced enhances this probability. CW-9 the environmental biologist is single, for example, has been away from his baccalaureate for four years and already has definite plans to return for Ph.D. study. The same can be said of CW-10 who, though married, has been away from her baccalaureate for only a year and has definite plans for Ph.D. study. CW-6, single and away from her baccalaureate for only a year has definite plans for Ph.D. study. So does CW-8, married and away from the baccalaureate for three years. By way of contrast, CW-1 has been away from his baccalaureate for 12 years, is married and although he has thought of returning for Ph.D. study, has no definite plans to do so. On the other hand, time away from baccalaureate is not a clear predictor. CW-2, CW-3 and CW-4 had all been away from their baccalaureates for one year. All reported that they had thought about the Ph.D. but none had definite plans to pursue the degree. All said that they may develop such plans sometime in the future.

On balance, the corporate sector could yield significant numbers of minority doctoral starts in science and engineering doctoral programs. Four of the eleven interviewees in this study had definite plans to pursue a doctorate in science and engineering. Granted that words not deeds are in play here, this ratio is remarkable. The average college graduating class yields about six of 100 people entering doctoral study - eventually. If only one of these young minority corporate professionals actually leaves his or her job and returns to school for doctoral study, and if this is repeated annually in several hundred corporations, NSF's Minority Initiative could be well ahead of the game.

Incentives to Return for Ph.D. Study

Predictably, money is the incentive needed to bring these young people back to the campus for doctoral study. As one interviewee noted: "You best try to get these people into the program before they get out here and start making $40-50,000." Or as another said so well to the question of the biggest challenge to going back: "Being a penniless student again."

When asked to indicate the type of support needed to enable them to do Ph.D. study, three of the four individuals noted that they would need stipends to cover living costs, tuition and benefits. The fourth said 70-80 percent of take-home salary. This individual had been on a payroll for only a year and earned about $30,000 a year, perhaps $24,000 after taxes and benefits deductions. Tuition, stipend and benefits packages of McKnight-type packages even out to about the latter figure, all tax free.

Predictably, the more family responsibility interviewees had encumbered, the greater the incentive needed to get them back onto the campus. CW-11, for example, would need a scholarship equal to his salary as a research biochemist to return. He is married, has a child and has been away from his baccalaureate five years.

A somewhat surprising development was the number of interviewees stipulating the need for assurances that they would be able to return to the same job at a higher level of compensation when the Ph.D. was completed and the numbers who wanted assurances that a Ph.D. degree would indeed bring some sort of advancement and added compensation. Attempts to recruit such individuals must begin with the knowledge that many corporate prospects have these concerns in mind and recruiters must address the concerns early on in their conversations.

A number of safeguards regarding Ph.D. program operations must be in place and must be made clear, it seems. CW-2 mentioned clear, concise stipulations of everything that would be needed to get the degree. So did CW-4 who also mentioned a clear schedule for meeting requirements and alternatives for completing requirements. CW-5: "Crystal clear requirements, Ph.D. work can be very uncertain." CW-6: "Support from department chair, stability of professor you're working with." CW-7: "Be clear about what is required. Have heard stories of highly subjective Ph.D. programs where whims of professors jerk people around." CW-8: "Support of faculty sensitive to minorities." CW-11 wants assurances that program he is enrolled in would not be canceled by the administration for some reason or another. Scientists and engineers are nothing if not careful about what they venture into.

Corporate Courses Completed Which May Help in Ph.D. Study

CW-2, an IBM electrical engineer has taken advanced computer architecture and microprocessor operating systems in her corporate training programs. Both would put her ahead of the game if she decided to return to campus for a Ph.D. CW-6, a chemical engineer, had completed corporate courses in "specialty engineering and quality control" which she felt might be useful and CW-8 has a considerable amount of hands-on learning from time she has spent on a research team. CW-9 felt the steady stream of environmental safety seminars she has taken prepared her well for Ph.D. study in environmental biology and CW-11 had taken several mainframe computer courses he felt would be useful to a Ph.D. aspirant. He has thought of returning for a biology degree.

Suggestions to NSF for Assuring a Successful Minority Initiative

Like minority science and engineering doctorate holders interviewed above, minority corporate scientists and engineers urge NSF to be as creative as possible in reaching children at an early age and developing both their interests and their talents. These corporate professionals see a big role for corporations in this work. On any given day, it seems, a gaggle of minority children would be coursing through the labs and production areas, watching science and engineering at work and watching people like themselves doing S&E work. For the adolescents there would be lab jobs in summer, the proverbial test tube washers, and more. "Shadowing" was a term used on more than one occasion. Here the high school student becomes a constant companion of the scientist or engineer, handing him/her tools, listening as the task is talked through to completion, discussing what went on and more.

CW-6 wants guilds involved more than has been the case. She wants NSF money flowing to the National Society of Black Engineers for an agenda which dovetails with the NSF Initiative. Alumni clubs of universities in metro areas are also likely candidates for projects. Many are looking for some way to help but lack an agenda. For CW-8: "Advertise, there are many programs out there but people don't learn about them." "Network hard!"

CW-9 wants NSF to approach corporations for corporate sponsored worker/Ph.D. students. This may be the most creative suggestion of all. The investigators have seen such a program in action. It is very effective and it effectively addresses the reluctance of people on a payroll to leave it for stipends and scholarships. Tax write-offs coupled with iron-clad contracts for return to the corporation for a specified number of years will convince many corporations of the value of such a program of corporate staff development.

When the Ph.D. as corporate staff development is coupled with dissertation research completed in corporate laboratories, we may have a new form of doctorate production which will help us address the problem of shortfalls in minority doctorate production in a highly effective way. The Ph.D. program in policy planning and evaluation at the Rand Graduate Institute (Rand Corporation) immediately comes to mind. It is a program which has been closely studied by the investigators (Brazziel, 1988) and it may be of great value in the present situation. Some of the doctorate recipients in the present study completed their dissertations in government laboratories.

In addition to corporate S&E professionals, the investigators felt that the technical schools of the armed forces might enroll young minority people who if worked with early on might continue on to the Ph.D. degree in science and engineering. We thought especially about the Community College of the Air Force, which at 500,000+ enrollees is by far America's largest college. We decided therefore to interview young airmen and airwomen at Westover Air Force Base of Chicopee, MA. A former CCAF student completing a psychology baccalaureate at the University of Connecticut was interviewed. Soldiers from the Massachusetts National Guard (Springfield Armory) were also interviewed and two artillery veterans enrolled at the University of Connecticut were interviewed. They were studying chemistry and physical therapy, respectively. The essence of these interviews follow. Summaries of the interviews along with codes, rank and military units of these young people can be found in Appendix D.

FINDINGS: INTERVIEWS WITH POSSIBLE MINORITY DOCTORAL PROSPECTS - MILITARY PERSONNEL

Like the interviews with corporate workers, our conversations with these young people began with hometown and family. We then progressed to the military unit they served in, the tasks they were assigned in these outfits and, importantly, the training courses and CCAF (Community College of the Air Force) or other college programs they were completing. Air Force enlistees are automatically enrolled in one of six CCAF associate in science degree programs when they sign up for duty. Certain of their Air Force technical courses are applied toward the CCAF-AS degree. Their general education requirements are completed at colleges brought on-base to offer such. The U.S. Army does not have a community college - yet. It competes with the Air Force for students by enrolling interested enlistees in civilian colleges which have agreed to participates as Servicemen's Opportunity Colleges. This is done on the day the young people enlist. Soldiers then take college courses on or near their army bases all around the world. Credits amassed are automatically recorded in registrars' offices in the soldiers' Servicemen's Opportunity Colleges.

It is important to emphasize again that the level of intelligence in the armed forces is now higher than in the general public and fully 100 percent of the Air Force enlistees are high school graduates. Army and Navy enlistees are rapidly nearing this standard. The top three percent of young armed forces enlistees today would probably have little difficulty completing a science or engineering Ph.D. Further, they would bring a drive and a discipline to their studies many civilian students have yet to know.

About the Interviewees

We interviewed a former Westover Field Air Force sergeant who transferred 28 credits from the Community College of the Air Force to the University of Connecticut. He is completing a degree in psychology and his main source of support is the G.I. Bill. He is interested in pursuing a Ph.D. eventually.

We interviewed a young Massachusetts Air National Guardsman who is taking CCAF technical courses at Westover Field and general education courses at Holyoke Community College. The interviewer was the first Ph.D. holder he had ever talked to and he was not sure about what a Ph.D. really was and what they really do. His parents came to Massachusetts from Puerto Rico when he was five years of age. After an hour or so of conversation, he said that maybe a Ph.D. was for him and thanked the interviewer for "turning me on to this opportunity."

We interviewed a young chemistry student at the University of Connecticut who was recently discharged from an artillery battalion in Fort Sill, Oklahoma. His home is New Britain, CT. He attended Cameron University in Oklahoma under the Servicemen's Opportunity Program and transferred 32 credits into the University. He plans to study for the Ph.D. and become a college professor.

We interviewed a young veteran of the U.S. Army who served in a health corps unit at Fort Meade, Maryland. He is studying physical therapy at the University of Connecticut. He noted that he may or may not study for the Ph.D. as physical therapists usually worked with a master's degree.

We interviewed a young Massachusetts National Guardsman from the Springfield, Massachusetts Armory (104th Infantry). He is currently pursuing an associate in science degree in public safety at Springfield Technical and Community College. He plans to study civil engineering at the University of Massachusetts. He is interested in a Ph.D. degree.

We interviewed a young man from the 91st Medical Technical Support Company of the Massachusetts National Guard. His life plans are remarkably clear. He plans to complete his Associate in Science degree in medical technology at Springfield Technical and Community College. He then plans to enroll in a sports medicine program at the University of Massachusetts. He definitely plans to complete a Ph.D. This a very confident and focused young man. One sensed that he would carry out his plan without too much difficulty.

We interviewed three prototype Community College of the Air Force students.

All were airpersons with the U.S. Air Transport Command and all were stationed at Westover Air Force Base in Massachusetts. All had high aspirations: electrical engineering "eventually," corporate chemist "somewhere down the road," genetic engineering "if I can swing it." All were enrolled in CCAF programs which would lead them to such careers. All were interested in a Ph.D. All were enrolled in off-base colleges and universities for general education courses. Good Ph.D. prospects.

Support Needed to Pursue a Ph.D.

MS-1 (Military Student-1) estimates he would need $1800 a month (for nine months) plus tuition and health benefits to support himself and his family if he entered a Ph.D. program. MS-2 talked about $2000 a month, tuition and benefits. He is also married. MS-3 who is single estimates he could make it on $1700 per month plus tuition and benefits. At 19 years old and single, MS-3 thought he could get by on $1200 a months plus tuition and benefits.

Generally, the younger the interviewees and the lighter their family responsibilities, the lower their estimates of what they would need in the way of support to pursue a Ph.D. degree. This is predictable of course. Most important here is that almost all of the interviewees indicated serious interest in pursuing a Ph.D., even the young man who initially did not know what it was. One came away with the impression that the Armed Forces comprise fertile ground for NSF and college and universities looking for highly capable, ambitious minority students who will complete a Ph.D. degree in science or engineering. Again, minorities comprise a third or more of America's Armed Services. According to our estimates, fully a third of each minority cohort of high school graduates joins one of the branches of the Armed Services. Again, their levels of intelligence exceed that of the general population.

Other Needs for Ph.D. Study

Recognizing that it is a long journey from an army barracks to a Ph.D. graduation ceremony, or for that matter, entrance to a Ph.D. program. We asked the interviewees 12 leading questions involving the challenge of getting through college and enrolling in, and completing, a Ph.D. program. Most important for planners, almost all indicated they would like to have help all the way through college to prepare them and enable them to get into a Ph.D. program.

Most, and particularly the younger servicepersons, needed to know more about the Ph.D.: what it is all about, what its holders do, how much money they make, job prospects after completion of a program, and more.

Almost all of the non-veterans indicated they would need and welcome help in transferring from a two-year college like CCAF into a four-year college like the University of Massachusetts. In addition, both veterans and servicepersons who were married picked out housing assistance as a need.

Significantly, although the most advanced individual in the group was a university junior, the young people echoed the concerns expressed by doctorate recipients in the first two groups of interviews: The adviser is paramount to success. Almost to a person, the young people agreed they needed an adviser who was "on their side" and a university which was "on their side."

Significantly, too, most of the young people indicated they would need help in explaining the Ph.D. and its requirement of several years of study beyond the baccalaureate to their parents and other relatives. These are quality young people but one must remember that fewer of their relatives will have college backgrounds and that most people in their communities who complete college degrees go directly to work.

All-in-all, the interviews were rewarding. Interest in Ph.D. study was high among young people with science and engineering talent. These young people will need considerable work, but 18-20 year-old predoctoral students everywhere need considerable work. The challenge here is for universities with NSF assistance to develop contact with such individuals early on in their CCAF or SOC career, to guide them, encourage them and, eventually, develop their talents.

SUMMARY FINDINGS

To reiterate, the purpose of this study was to examine science and engineering doctorate production among minorities with non-traditional baccalaureate origins and to examine the correlates of their efficacy in completing the doctorate. A second purpose of the study was to explore corporations and the Armed Forces as possible non-traditional sources of minority science and engineering doctoral students.

The first order of business, of course, was to answer the question of whether non-traditional students go on in any significant numbers to complete doctorates in science and engineering. Indeed, whether such a thing is possible. We then needed to know as much as possible about these individuals and, finally, we needed to conduct an examination of the potential for expanding non-traditional talent pools, from colleges and universities to talent pools among corporations and the branches of the Armed Forces. Accordingly, our study:

1. Identified the extent to which minority science and engineering doctorate recipients with non-traditional baccalaureate origins were represented among all minority science and engineering doctorate recipients over a recent ten-year period of time.

2. Compared key educational and demographic characteristics of minority science and engineering doctorate recipients with non-traditional baccalaureate origins with minority science and engineering doctorate recipients with traditional baccalaureate origins.

3. Tested and compared selected predictors of elapsed and registered times to degree for non-traditional minority student and traditional minority student doctorate recipients.

4. Corroborated and buttressed perceptions gained and insights gleaned from the statistical analyses through interviews with groups of non-traditional and traditional minority student doctorate recipients.

5. Elicited suggestions for assuring success of the National Science Foundation's Minority Initiative for Doctoral Study from non-traditional minority student and traditional minority student doctorate recipients.

6. Examined the possibility of tapping talent pools of young minority science and engineering professionals in corporations to expand doctoral starts among minority groups by interviewing a group of such individuals.

7. Examined the possibility of tapping talent pools of young minority science and engineering specialists in the Armed Services as a source for eventually expanding doctoral starts among minority groups by interviewing a group of such individuals.

A summary list of our findings follows. They are stated as succinctly and as parsimoniously as possible.

Minorities with non-traditional baccalaureate origins do go on to complete doctorates in science and engineering. Indeed, they comprised 16.9 percent of the 7235 minority science and engineering doctorate recipients in this sample. Again, Asians were not included in the sample.

Non-traditional minority student science and engineering doctorate recipients were well represented in the major science and engineering fields, i.e., physical science, life science, social science and engineering. They were overrepresented in social science with 58 percent taking their degrees in this field compared to 47 percent for their traditional student counterparts.

Non-traditional student science and engineering doctorate recipients matched their traditional student counterparts in elapsed time from baccalaureate to doctorate, 10.6 years for each, and in registered time to doctorate, slightly more than seven years for each group. Both groups compared favorably with elapsed and registered time to degree of recent doctorate recipients from American colleges and universities and, like their counterparts elsewhere, field of study made a difference in both measures with physical science recipients completing first (elapsed time = 8.83 and 8.6 years) and social science recipients bringing up the rear (elapsed time = 10.5 and 10.6 years).

Fewer women than men were represented among the non-traditional recipients, slightly more than 29 percent compared to nearly 41 percent for their traditional student counterparts.

Predictably, the non-traditionals finished their degrees at a later age than the traditionals: 34.5 vs. 32.5 years of age on average.

Nearly 27 percent of the non-traditionals and 9.4 percent of the traditionals had attended junior or community colleges (JUCOs).

Fewer non-traditionals reported either the university or the federal government as their primary source of support, 34 to 54 percent when compared to traditionals.

Further, fathers were less able to help non-traditionals with any kind of college study. Fully 45 percent had not completed high school and only 15 percent had completed college. Nearly 34 percent of fathers of their traditional counterparts had completed college, 14 percent had completed a master's degree and 5.4 percent had completed a doctorate or first professional degree. Father's education is the best indicator available for ability of the family to support college attendance.

The term fortitude comes to mind as we study the profile of the minority science and engineering doctorate recipient with a non-traditional baccalaureate origin. This individual had less financial backing from family to begin a college career and less financial backing from universities and the government to finish it with a doctorate. He/she still came through in fine style, however, taking just two years longer than her/his more fortunate counterparts to complete the degree. Remarkable.

Seven of the predictors tested for elapsed time to degree of the traditionals explained 12 percent of the variance in completion time while two variables accounted for five percent of the variance among non-traditional recipients. Primary sources of support, father's education and field of study were leading predictors for the former group while primary source of support and JUCO attendance were key predictors for the latter. The amount of variance accounted for would be considered modest in some instances. For a venture as individual as getting a Ph.D. degree, it must be considered significant.

When disaggregated by field of study, at least two variables, and on average four variables, emerged as predictors of elapsed time to degree for the traditional group while only one variable each for life science and social science recipients emerged for the non-traditionals. Ten percent of the variance was explained for traditionals majoring in life science and 9.4 percent for those majoring in social science. Eight and five percent of the variance was accounted for, respectively, for non-traditionals majoring in these fields.

Our perceptions and insights gleaned from the statistical analyses at this point were quite positive indeed. We were impressed that:

Non-traditional minority students went on to the doctorate in significant numbers. This augurs well for The NSF Minority Initiative's concentration on this group.

Non-traditional minority student doctorate recipients were well-represented in every field of study.

A manipulatable variable, **Money**, emerged as the prime predictor of measures of success. Excellent support of doctoral study meant early completion of the doctorate. **Money** will also mean more applicants and doctoral starts in the affected fields if more of it becomes available to aspiring doctoral students.

Over 27 percent of non-traditional minority student science and engineering doctorate recipients and 9.7 percent of the traditionals had attended junior and community colleges. This augurs well for The NSF Minority Initiative's work with these schools. Over half of all minorities begin their college careers in JUCOs and nearly 45 percent are enrolled in these schools at any given time.

Our interviews with minority doctorate recipients with both traditional and non-traditional baccalaureate origins buttressed the perceptions and insights gained from the statistical exercises. We came away from the interviews impressed with the sheer brilliance of some of the recipients in both groups and completely convinced that an NSF Minority Initiative which incorporates work with non-traditional science and engineering students would bear fruit. In addition, their suggestions for enabling initiatives were impressive.

The interviews bore out our perception as gleaned from the statistical exercises that **Money** is undoubtedly the most decisive factor in increasing doctorate production in science and engineering among minority groups. Increasing the number of qualified applicants is important - for the long haul - to be sure, but we seem to have enough qualified people already at hand for the Minority Initiative to begin a significant march forward. Many of our interviewees received assistance from the McKnight Foundation which provides excellent support for minorities studying for science and engineering doctorates. The interviewees waxed rhapsodic about the program of course but, significantly, the director noted in an interview that it is always oversubscribed, with several times as many good applicants turned away as accepted. The interviewee who advised us not to waste our time studying the situation but to quickly "clone McKnight," is probably right. In any case, the oversubscription of this program and others such as the Meyerhoff Scholars Program of the University of Maryland-Baltimore County explodes the myth propagated by naysayers - the bane of initiatives like this - that there aren't any qualified minority students out there. And that there never will be until minorities become more like the majority in education and income (Rothberg, 1990).

Limited prospects for increasing the number of university research and teaching assistantships awarded to minorities strengthens the view that scholarship aid such as McKnight and Meyerhoff will have to be employed. As noted earlier, large numbers of foreign nationals win research assistantships as

American professors look for the very best talent to help with their NSF and other federal agency research projects. Many foreign nationals are the very best students in their country. White students will continue to receive most of the teaching assistantships because of the reluctance of university programs and departments to use more than one or two minority teaching assistants at one time. Minorities will therefore have to depend on scholarships and fellowships.

Our interviews with minority corporate professionals and Armed Forces personnel were rewarding. We are convinced that corporations comprise prime pools of minority science and engineering talent **and that NSF could tap this talent pool right now** with efforts to engender close attention to and cooperation with corporations on the part of universities. Minority government professionals were not interviewed but the same would hold true for these individuals no doubt. The best advice from interviewees: **Put up the Money and Advertise**.

Our interviews with young members of the Armed Forces were doubly rewarding - and revealing. We found a pool of talented youngsters with a tremendous amount of drive and discipline, the very ingredients of a successful doctoral student. These young people were combining science and engineering college work with the discipline and rigor of military life. This approach may be the best innovation in science and engineering education to come along in many years. Without a doubt it is effective for youngsters with little or no money. Each year upward of 12-14,000 associate in science degrees are awarded by the Community College of the Air Force alone. This figure does not include transfers into four year colleges and universities before graduation. This figure will easily double in the next decade. The NSF Minority Initiative must find a way to reach out to these young people.

CONCLUSIONS

In conclusion, we believe that findings from our study suggest that the National Science Foundation's Minority Initiative could be enhanced significantly if officials could find ways to:

1. Increase the number of scholarships and fellowships available to minority students, i.e., heed the urgings of interviewees and "Clone McKnight."

2. Encourage universities to recruit and admit more older minority students (say 25-32) with science and engineering baccalaureates.

3. Encourage more junior and community colleges to develop doctoral preparatory experiences for talented minority science and engineering students and head them toward doctoral study. NSF grants to these institutions for laboratories and partnerships with universities and corporations would be invaluable here.

4. Encourage more young minority science and engineering professionals with corporations to embark upon a doctoral program..

5. Encourage more corporations to underwrite doctoral study for their minority science and engineering professionals. Or supplement NSF scholarships and fellowships to the point that the necessity for leaving the payroll at a great loss in income would be diminished.

6. Encourage young minority members of the Armed Forces with unusual science and engineering talent to aim for a Ph.D. in these fields. Encourage universities to look for talent at their nearest military base. Award grants for this outreach.

7. Encourage more universities to break away from the policy of enrolling one minority at a time, "quotas of one," and enroll clusters of same-race students in their science and engineering Ph.D. programs.

8. Encourage more universities to enroll high B+ minority students at the same rate they enroll high B+ white students.

9. Encourage all universities to improve their advising systems for all students and for minority students in particular.

10. Encourage more universities to effect arrangements for joint dissertation research with corporations and government agencies.

Finally, we fervently believe the NSF Minority Initiative must succeed. The continued health and prosperity of America depends on it. Our nation simply cannot continue to move forward without fully utilizing the talents of a third of its people. Hopefully, our study will make some small contribution to this very important undertaking.

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APPENDIX A

INTERVIEW SUMMARIES: MINORITY SCIENCE AND ENGINEERING DOCTORATE RECIPIENTS - TRADITIONAL STUDENTS

Marian Brazziel Associates
National Science Foundation Doctoral Study

Interview Schedule

Subjects: Traditional Minority Student Doctorate Recipients

The National Science Foundation is mounting a national effort to increase the number of minority doctorate recipients in science and engineering. The Foundation is turning to minorities who have completed such degrees for advice and guidance.

We are pleased you have agreed to help in the interviews the Foundation has asked us to conduct in this respect. Your interview will be confidential, of course, and we will include any open-ended comments you want to make.

1. What was the elapsed time from your baccalaureate to your doctorate degree?

2. What was your primary support for study toward your master's degree?

3. What was your primary support for study toward your Ph.D. degree?

4. What was your major field of study? Your minor field, if any?

5. From which university did you receive your degree?

6. At what age did you complete your baccalaureate degree? Your doctorate?

7. Are you an Armed Forces veteran?

8. Did you attend a community or junior college? Complete a JUCO degree?

9. What were the three most difficult challenges of your doctoral experience?

10. What are the three most important considerations for the National Science Foundation as it mounts its program to attract more minority students to science and engineering doctoral study?

11. What are the three most important considerations for universities which will receive these young people?

12. What are the three most important considerations for professors who will direct the doctoral programs of these young people?

13. Do you have any advice to any of the parties involved in this new program?

Thank you very much for helping us with these interviews. Please know that the National Science Foundation is also grateful for your help.

If you think of anything else which would help the Foundation do a good job with this new program, please call me and I will include it in my report.

National Science Foundation Interviews
Minority Doctorate Recipients: Traditional Students

TS-1

Legend: TS = Traditional Student

* Present Post: Assistant Professor of Computer Science, Florida State University

* Elapsed Time, Baccalaureate to Ph.D.: 12 years

* Completed Baccalaureate at 21, Ph.D at 33

* Major Field: Computer Science

* Ph.D. Granting University: Florida State University

* Baccalaureate Institution: Florida State University

* Master's Institution: Florida State University

* Primary Source(s) of Support: McKnight Fellowship

* Is not a veteran and did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

- o Selecting a professor to serve as adviser
- o Changing the professor when things didn't seem to go well
- o Settling on a research topic for the dissertation

* Advice to NSF Regarding The Minority Initiatives:

- o Start with elementary school children, nurture them before they have developed a fear of science and engineering although many have abilities in these areas
- o Provide adequate financial support, build in cost of living increases
- o Provide for family allowances, e.g., $15,000 plus tuition and fees is adequate for single students but completely inadequate for families

* Advice to Universities Regarding the New Minority Initiative:

- o Do everything possible to lessen the isolation of minority students, e.g., recruit clusters of same-race students to enter the same class of Ph.D. starts; use them to show the next cluster the ropes etc.

National Science Foundation Interviews
Minority Doctorate Recipients: Traditional Students

TS-2

Legend: TS = Traditional Student

* Present Post: Research Analyst, 3M Corporation, Minneapolis, MN

* Elapsed Time, Baccalaureate to Ph.D.: eight years

* Completed Baccalaureate at 23, Ph.D. at 31

* Major Field: Pharmacology

* Ph.D. Granting University: Florida A&M University

* Baccalaureate Institution: Payne College, Augusta, GA

* Master's Institution: Florida A&M University

* Primary Source(s) of Support: Florida Endowment Fund (doctorate) MBRS (Minority Baccalaureate Research Society) for baccalaureate, and RCM (Research Centers for Minorities) for master's study

* Is not a veteran and did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

- o Transition from baccalaureate routines and work loads to graduate study and work loads, e.g., long laboratory hours, heavy reading assignments
- o Classroom and laboratory competition. Much stiffer than anticipated
- o Finding enough money to support ones self independently

* Advice to NSF Regarding The Minority Initiative:

- o Provide fellowships in the neighborhood of $16,000 - $18,000
- o Develop a visiting student program for students who might want to complete some or all of their dissertation research at corporations or at other universities where the facilities, and most important, the researchers are more in keeping with the chosen topic

* Advice to Universities Regarding The Minority Initiative:

- o Develop effective orientation programs for new graduate students, many have to wander around and learn the ropes by trial and error

National Science Foundation Interviews
Minority Doctorate Recipients: Traditional Students

TS-3

Legend: TS = Traditional Student

* Present Post: Technical Staff Person, Rand Corporation, Washington, DC

* Elapsed Time, Baccalaureate to Ph.D.: Six Years

* Completed Baccalaureate at 21, Ph.D. at 27

* Major Field: Physics

* Ph.D. Granting University: Stanford

* Baccalaureate Granting University: MIT

* Master's Granting University: None. Went from baccalaureate to Ph.D.

* Primary Source(s) of Support: Research Assistantship and Bell Labs

* Is not a veteran and did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

- o Finding the right research group
- o Getting the experiment to work
- o Starting over when the experiment did not work

* Advice to NSF Regarding the Minority Initiative:

- o Encourage the establishment of Society of Physics and other support organizations on campuses and among alumni groups
- o Provide opportunities for minority students to see role models at work in the field of physics
- o Help students get outside funding for living expenses and for their research projects

* Advice to Universities Regarding The Minority Initiative:

- o Increase minority role in university governance
- o Increase number of minority students in program, move past tokenism

National Science Foundation Interviews
Minority Doctorate Recipients: Traditional Students

TS-4

Legend: TS = Traditional Student

* Present Post: Chief Executive Officer, ASCI Corporation, Arlington, VA

* Elapsed Time, Baccalaureate to Ph.D.: seven years

* Completed Baccalaureate at 21, Ph.D. at 28

* Major Field: Electrical Engineering

* Ph.D. Granting University: University of Southern California

* Baccalaureate Institution: Brown University

* Master's Institution: University of Southern California

* Primary Source(s) of Support: Hughes Doctoral Fellowship

* Is not a veteran and did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

o Selecting a dissertation topic

o Passing the qualifying examinations for candidacy

o Getting approval from the adviser to begin the dissertation

* Advice to NSF Regarding The Minority Initiative:

o Provide adequate financial support

o Work with professors to help them gain confidence in working with minority students. Stress that these students must feel that professors are "on their side"

o Work with potential students as early as possible so that they have a tremendous commitment to getting a degree in a difficult field

* Advice to Universities Regarding The Minority Initiative:

o Have black professors as role models in the schools and departments. Many schools feel that Asian and Indian professors will suffice as role models since they are indeed minority people. This simply is not the case

National Science Foundation Interviews
Minority Doctorate Recipients: Traditional Students

TS-5

Legend: TS = Traditional Student

* Present Post: President, ASCI Corporation, Arlington, VA

* Elapsed Time, Baccalaureate to Ph.D.: 6.5 years

* Completed Baccalaureate at 21, Ph.D. at 27

* Major Field: Physics

* Ph.D. Granting University: Stanford University

* Baccalaureate Institution: Massachusetts Institute of Technology

* Master's Institution: Stanford University

* Primary Source(s) of Support: Research Assistantship, Teaching Assistantship, Bell Laboratories

* Is not a veteran and did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

o Finding the right research group to begin dissertation project

o Getting the dissertation experiment to work

o Starting all over again when the dissertation experiment did not work

* Advice to NSF Regarding The Minority Initiative:

o Encourage the development of organizations such as the Society of Physics on campuses along with other support groups and organizations

o Develop opportunities for minority students to see role models in jobs they are interested in

* Advice to Universities Regarding The Minority Initiative:

o Increase minority roles models on campuses, especially in departments

o Increase the number of minority students in the program. This is especially true of black students. Many universities admit one black student at a time, a quota of sorts - of one. This is unfortunate

National Science Foundation Interviews
Minority Doctorate Recipients: Traditional Students

TS-6

Legend: TS = Traditional Student

* Present Post: Assistant Professor of Mathematics Education, University of South Florida

* Elapsed Time, Baccalaureate to Ph.D.: 10 years

* Completed Baccalaureate at 21, Ph.D. at 31

* Major Field: Mathematics

* Ph.D. Granting University: Florida State University

* Baccalaureate Institution: Georgia Southern University

* Master's Institution: Georgia Southern University

* Primary Source(s) of Support: McKnight Fellowship

* Is not a veteran and did not attend a junior or community college

*Three Most Challenging Doctoral Experiences:

o Leaving a job and coming back to school on reduced income

o Resisting the temptation to become an ABD when money became short

o Reduction of stress and anxiety over getting out

* Advice to NSF Regarding The Minority Initiative:

o Fund programs for elementary children. High school, or even junior high school is too late

o Pick out 80-90 universities and concentrate minority Ph.D. training in these schools, thus assuring a critical mass of minority students

o Urge the institutions to develop a critical mass of minority faculty members. They will comprise all-important role models and can be counted on to give valuable advice and assistance on an informal basis.

* Advice to Universities Regarding The Minority Initiative:

o Build up a critical mass of minority students. Encourage study groups

National Science Foundation Interviews
Minority Doctorate Recipients: Traditional Students

TS-7

Legend: TS = Traditional Student

* Present Post: Research Fellow in Pharmacology, University of Kansas Medical Center, Kansas City, MO

* Elapsed Time, Baccalaureate to Ph.D.: 10 years

* Completed Baccalaureate at 21, Ph.D. at 31

* Major Field: Pharmacology

* Ph.D. Granting University: Florida A&M University

* Baccalaureate Institution: Florida A&M University, transfer from Morehouse College

* Master's Institution: Florida A&M University

* Primary Source(s) of Support: Florida Endowment Fund (doctorate) MBRS (Minority Baccalaureate Research Society) for baccalaureate, and RCM (Research Centers for Minorities) for master's study

* Is not a veteran and did not attend a junior college

* Three Most Challenging Doctoral Experiences:

  o Transition from biological sciences to pharmacology

  o Finding a dissertation topic and an adviser to direct the dissertation

  o Learning all of the requirements and meeting them

* Advice to NSF Regarding The Minority Initiative:

  o Clone the Florida Endowment Fund's selection philosophy, i.e., in addition to blue ribbon students, look for high B+ students

  o It is only by involving high B+ as well as high A- or A students can we effect significant expansion in the ranks of minority doctorates in science and engineering. Most whites in program high B+, most blacks high A-

* Advice to Universities Regarding The Minority Initiative:

  o Same as above re high B+ students.

National Science Foundation Interviews
Minority Doctorate Recipients: Traditional Students

TS-8

Legend: TS = Traditional Student

* Present Post: Director, Puerto Rican Cultural Center, University of Connecticut

* Elapsed Time, Baccalaureate to Ph.D.: 17 years

* Completed Baccalaureate at 23, Ph.D. at 40

* Major Field: Anthropology

* Ph.D. Granting University: Stanford University, Field: Anthropology

* Baccalaureate Institution: University of Connecticut

* Master's Institution: Stanford University

* Primary Source(s) of Support: Self

* Is not a veteran, did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

  o Breaking away from job to complete degree

  o Finding money to support self and family

  o Finding a good adviser

* Advice to NSF Regarding The Minority Initiative:

  o Understand the deep commitment to family in Latino culture, students may have to interrupt studies to find a way to assist close relatives who are ill, facing financial ruin or who are otherwise distressed

  o Provide ample financial aid. Most Puerto Rican students have limited resources

  o Provide recruitment funds for universities to recruit in Puerto Rico as well as on the mainland

* Advice to Universities Regarding The Minority Initiative:

  o Provide language training facilities for students to polish English

National Science Foundation Interviews
Minority Doctorate Recipients: Traditional Students

TS-9

Legend: TS = Traditional Student

* Present Post: Principal, Maloney High School, Meriden, CT

* Elapsed Time, Baccalaureate to Ph.D.: 13 years

* Completed Baccalaureate at 22, Ph.D. at 35

* Major Field: Sociology

* Ph.D. Granting University: University of Connecticut

* Baccalaureate Institution: University of Connecticut

* Master's Institution: University of Connecticut

* Primary Source(s) of Support: Self

* Is not a veteran, did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

o Managing family while doing graduate study

o Saving money to do graduate study

o Long commutes from Meriden to Storrs to attend class, use library

* Advice to NSF Regarding The Minority Initiative:

o Start kids early in science and engineering enrichment experiences. If they are not involved by fourth grade they probably will not major in these subjects. Take lessons from techniques of Soviet Russia and get kids in touch with good lab facilities as soon as possible

o Provide ample financial aid. Puerto Rican students are generally poor

o Involve as many students as possible in science and engineering Upward Bound-type programs

* Advice to Universities Regarding The Minority Initiative:

o "Work to have faculty understand where Puerto Rican students are coming from, little things mean a lot and it is so easy to mis-communicate."

National Science Foundation Interviews
Minority Doctorate Recipients: Traditional Students

TS-10

Legend: TS = Traditional Student

* Present Post: Research Engineer, Bell Communications, Red Bank, NJ

* Elapsed Time, Baccalaureate to Ph.D.: 5 years

* Completed Baccalaureate at 22, Ph.D. at 27

* Major Field: Electrical Engineering

* Ph.D. Granting University: University of Florida

* Baccalaureate Institution: Southern University

* Master's Institution: University of Florida

* Primary Source(s) of Support: McKnight Foundation

* Is not a veteran, did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

  o Settling on a topic.

  o Getting the university to buy the needed equipment for the research.

  o Ran out of money.

* Advice to NSF Regarding The Minority Initiative:

  o Don't withdraw funding after two or three years for people who are near their degree. Plan to have fewer people in the pipeline, but more people completing the programs. Don't let the NSF program become a revolving door.

  o Provide ample financial aid. Most minority students have limited funds

  o Provide recruitment funds for universities to recruit on a national basis

* Advice to Universities Regarding Minority Initiatives:

  o Develop a cadre of mentors in corporations and government agencies

  o Reward advisers who take on minority students in all of the myriad ways

National Science Foundation Interviews
Minority Doctorate Recipients: Traditional Students

TS-11

Legend: TS = Traditional Student

* Present Post: Research Physicist - City of Hope National Medical Center - Duarte, CA

* Elapsed Time, Baccalaureate to Ph.D.: 4 years

* Completed Baccalaureate at 21, Ph.D. at 26

* Major Field: Nuclear Engineering

* Ph.D. Granting University: University of Florida

* Baccalaureate Institution: University of Virginia

* Master's Institution: University of Virginia

* Primary Source(s) of Support: McKnight Foundation

* Is not a veteran, did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

o Dealing with a professor who felt that black women did not belong in nuclear engineering

o Finding a topic

o Finding a good adviser

* Advice to NSF Regarding The Minority Initiative:

o Provide plenty of money

o Talk up the program everywhere; some of these thing go on and people who might benefit from them have no idea they exist

o Provide recruitment funds for universities to recruit nationally

* Advice to Universities Regarding The Minority Initiative:

o Have a strong minority assistant dean to help students

o Make it clear that the university is behind the NSF Minority Initiative

National Science Foundation Interviews
Minority Doctorate Recipients: Traditional Students

TS-12

Legend: TS = Traditional Student

* Present Post: Assistant Professor of Psychology, Miami University of Ohio

* Elapsed Time, Baccalaureate to Ph.D.: 9 years

* Completed Baccalaureate at 21, Ph.D. at 28

* Major Field: Developmental Psychology

* Ph.D. Granting University: University of Florida

* Baccalaureate Institution: Troy State University of Alabama

* Master's Institution: Meharry Medical College (Clinical Psychology Program)

* Primary Source(s) of Support: McKnight Fellowship

* Is not a veteran, did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

o Lack of a mentor in early stages. Finally found one

o Problems with advisor; lack of interest; lack of expertise

o Settling on a doable research project

* Advice to NSF Regarding The Minority Initiative:

o Fund activities at early ages for children

o Fund the development of community-based activities aimed at preparing children to study science and engineering, a sort of S&E Head Start

o Provide low-cost neighborhood boarding schools for gifted children in the meanest situations. Conserve this talent. Don't let it be wasted

* Advice to Universities Regarding The Minority Initiative:

o Encourage advisers to do a better job. Hold them accountable. Make good advising a part of the criteria for promotion and tenure Incorporate good advisement as part of criteria for awarding merit. Recognize good advisers in handing out kudos

APPENDIX B

INTERVIEW SUMMARIES: MINORITY SCIENCE AND ENGINEERING DOCTORATE RECIPIENTS - NON-TRADITIONAL STUDENTS

Marian Brazziel Associates
National Science Foundation Doctoral Study
Interview Schedule

Subjects: Non-Traditional Minority Student Doctorate Recipients

The National Science Foundation is mounting a national effort to increase the number of minority doctorate recipients in science and engineering. The Foundation is turning to minorities who have completed such degrees for advice and guidance.

We are pleased you have agreed to help in the interviews the Foundation has asked us to conduct in this respect. Your interview will be confidential, of course, and we will include any open-ended comments you want to make.

1. What was the elapsed time from your baccalaureate to your doctorate degree?
2. What was your primary support for study toward your master's degree?
3. What was your primary support for study toward your Ph.D. degree?
4. What was your major field of study? Your minor field, if any?
5. From which university did you receive your degree?
6. At what age did you complete your baccalaureate degree? Your doctorate?
7. Are you an armed forces veteran?
8. Did you attend a community or junior college? Complete a JUCO degree?
9. What were the three most difficult challenges of your doctoral experience?
10. What are the three most important considerations for the National Science Foundation as it mounts its Minority Initiative to attract more minority students to science and engineering doctoral study?
11. What are the three most important considerations for universities which will receive these young people?
12. What are the three most important considerations for professors who will direct the doctoral programs of these young people?
13. Do you have any advice to any of the parties involved in the Initiative?

Thank you very much for helping us with these interviews. Please know that the National Science Foundation is also grateful for your help.

If you think of anything else which would help the Foundation do a good job with this new program, please call me and I will include it in my report.

National Science Foundation Interviews
Minority Non-Traditional Student Doctorate Recipients

NTS-1

Legend: NTS = Non-Traditional Student

* Present Post: President, Health Marketing and Development Systems, Alexandria, VA

* Elapsed Time, Baccalaureate to Ph.D.: 19 years

* Completed Baccalaureate at 25, Ph.D. at 34

* Major Field: Health Services and Cybernetics

* Ph.D. Granting University: George Washington University

* Baccalaureate Institution: Howard University

* Master's Institution: George Washington University

* Primary Source(s) of Support: Self and spouse

* Is not a veteran and did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

  o Money; did not have any, had to finance own program

  o Finding a satisfactory topic and the money to buy the research equipment

  o Finding a good adviser who knew something about dissertation topic

* Advice to NSF Regarding The Minority Initiative:

  o Provide as much money to as many students as possible. If this is done, bright students will take it from there

  o Ask industry to provide lab experiences for both high school and college students

  o Begin with primary students and get them interested in S&E work (science and engineering)

* Advice to Universities Regarding The Minority Initiative:

  o Line up some good advisers. They are all-important. Recognize their important contributions in this area

National Science Foundation Interviews
Minority Non-Traditional Student Doctorate Recipients

NTS-2

Legend: NTS = Non-Traditional Student

* Present Post: Assistant Professor of Communications Sciences, Virginia Commonwealth University

* Elapsed Time, Baccalaureate to Ph.D.: 11 years

* Completed Baccalaureate at 25, Ph.D. at 36

* Major Field: Mass Communications

* Ph.D. Granting University: University of Florida

* Baccalaureate Institution: Hampton University

* Master's Institution: Syracuse University

* Source(s) of Support: McKnight Fellowship

* Is not a veteran and did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

- o Making the decision to give up the security of a college teaching job and go back to school, was married with a child to be born soon
- o Persisting in the face of great financial hardship
- o Making the mental transition from professor to student again

* Advice to NSF Regarding The Minority Initiative:

- o Will need a good public relations effort to convince many bright young people that getting a science or engineering degree can match the rewards of money to be received early on with an MBA or computer science degree
- o Need to zero in on very young people and make science a way of life
- o Provide family generous allowances for married people with children

* Advice to Universities Regarding The Minority Initiative:

- o Recruit 30-35 year-old students. Many science departments don't want to do this

National Science Foundation Interviews
Minority Non-Traditional Student Doctorate Recipients

NTS-3

Legend: NTS = Non-Traditional Student

* Present Post: Assistant Professor of Biology, Alabama A&M University

* Elapsed Time, Baccalaureate to Ph.D.: 13 years

* Completed Baccalaureate at 26, Ph.D. at 39

* Major Field: Environmental Engineering Sciences

* Ph.D. Granting University: University of Florida

* Baccalaureate Institution: University of Alabama

* Master's Institution: Alabama A&M University

* Primary Source(s) of Support: McKnight Fellowship

* Is not a veteran and did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

  o Deciding to go back to school and leave husband at home (500 miles away) to care for two small children

  o Being a black female in an all-white male department

  o Settling on a topic

* Advice to NSF Regarding The Minority Initiative:

  o Start with the primary grades. Involve the youngsters in science camps, science academies, young scholars programs et al for the next 12 years

  o Emulate the Meyerhoff Program at the University of Maryland-Baltimore where black students are recruited for Ph.D. programs in their senior year in high school

  o Streamline all paperwork for getting into any program

* Advice to Universities Regarding The Minority Initiative:

  o Develop more structure to the Ph.D. programs, e.g., state clearly what is required, write it down and give it to the students

National Science Foundation Interviews
Minority Non-Traditional Student Doctorate Recipients

NTS-4

Legend: NTS = Non-Traditional Student

* Present Post: Research Chemist, Rohaym Haas, Springhouse, PA

* Elapsed Time, Baccalaureate to Ph.D.: Five Years

* Completed Baccalaureate at 25, Ph.D. at 30

* Major Field: Chemistry

* Ph.D. Granting University: University of Florida

* Baccalaureate Institution: University of Central Florida

* Master's Institution: Did not take a master's degree

* Primary Source(s) of Support: McKnight Fellowship

* Is not a veteran. Attended a junior college for a year

* Three Most Challenging Doctoral Experiences:

o Keeping perspective amidst an upsurge of campus racism spawned by the White Student Union

o Keeping perspective in the face of negative remarks about black graduate students which were made publicly by the dean of the Graduate School

o Keeping perspective in the face of general disarray in the Graduate School due to resignations of a number of key people

* Advice to NSF Regarding The Minority Initiative:

o Begin early, with children afforded campus experiences as often as possible

o Money. Make sure the stipends are adequate

* Advice to Universities Regarding The Minority Initiative:

o Pair minority students with experienced advisers.

o Reward advisers who advise minority students

National Science Foundation Interviews
Minority Non-Traditional Student Doctorate Recipients

NTS-5

Legend: NTS = Non-Traditional Student

* Present Post: Associate Vice President for Academic Affairs, Dillard University

* Elapsed Time, Baccalaureate to Ph.D.: 27 years

* Completed Baccalaureate at 28, Ph.D. at 55

* Major Field: Counseling Psychology

* Ph.D. Granting University: University of Florida

* Baccalaureate Institution: Dillard University

* Master's Institution: Loyola University of New Orleans

* Primary Source(s) of Support: Florida Endowment Fund

* Is not a veteran and did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

    o Selecting a committee, the members of which would be able to work with one another

    o Passing the qualifying examinations

    o Completing the dissertation

* Advice to NSF Regarding The Minority Initiative:

    o Start with kindergartners, with science camps, science academies et al

    o Support mentorship programs beginning in junior high school

    o Provide black role models from corporations and universities

* Advice to Universities Regarding The Minority Initiative:

    o Create an atmosphere of welcome for minority students

    o Encourage minority students to find relaxation from the "campus grind," e.g., go to church in the community

National Science Foundation Interviews
Minority Non-Traditional Student Doctorate Recipients

NTS-6

Legend: NTS = Non-Traditional Student

* Present Post: Environmental Toxicologist, U.S. Center for Disease Control

* Elapsed Time, Baccalaureate to Ph.D.: 10 years

* Completed Baccalaureate at 30, Ph.D. at 40

* Major Field: Environmental Toxicology

* Ph.D. Granting University: Florida A&M University

* Baccalaureate Institution: Edward Waters College

* Master's Institution: Florida A&M University

* Primary Source(s) of Support: Masters: Minority Biomedical Research Program; Ph.D.: McKnight Fellowship

* Is a veteran but did not attend a junior college

* Major Field: Electrical Engineering

* Most Challenging Doctoral Experiences:

  o Writing the research protocol for the dissertation

  o Making the final defense of the dissertation

* Advice to NSF Regarding The Minority Initiative:

  o Expand the existing Fellowships for Minorities Program

  o Encourage more collaborations between universities and government agencies. Subject worked at Center for Toxicological Research and two scientists from the Center served on his doctoral committee

  o Start with science and engineering head start programs.

* Advice to Universities Regarding The Minority Initiative:

  o Have curriculums whose requirements are crystal clear to doctoral students

National Science Foundation Interviews
Minority Non-Traditional Student Doctorate Recipients

NTS-7

Legend: NTS = Non-Traditional Student

* Present Post: Professor of Physics, University of Connecticut

* Elapsed Time, Baccalaureate to Ph.D.: 4 years

* Completed Baccalaureate at 25, Ph.D. at 29

* Major Field: Physics

* Ph.D. Granting University: Pennsylvania State University

* Baccalaureate Institution: Pennsylvania State University

* Master's Institution: Pennsylvania State University

* Primary Source(s) of Support: National Science Foundation; G.I. Bill

* Is a veteran and attended a two-year branch of his university for the first year

* Three Most Challenging Doctoral Experiences:

  o Selecting a research topic

  o Completing the dissertation

  o Getting started in college late, served in the Air Force first

* Advice to NSF Regarding The Minority Initiative:

  o Start in the elementary grades

  o Find ways to alert students to job opportunities in less visible fields

  o Fund school-industry-university partnerships

* Advice to Universities Regarding The Minority Initiative:

  o Set up school partnerships where youngsters can come to the campus and be around researchers

  o Provide as many black role models as you can, in physics or closely related fields

National Science Foundation Interviews
Minority Non-Traditional Student Doctorate Recipients

NTS - 8

Legend: NTS = Non-Traditional Student

* Present Post: Principal, Prince School, New Haven, CT

* Elapsed Time, Baccalaureate to Ph.D.: 12 years

* Completed Baccalaureate at 29, Ph.D. at 41

* Major Field: Psychology

* Ph.D. Granting University: University of Connecticut

* Baccalaureate Institution: University of Puerto Rico

* Master's Institution: University of Connecticut

* Primary Source(s) of Support: Self

* Is not a veteran, but did attend a junior college: University College of Puerto Rico

* Three Most Challenging Doctoral Experiences:

- o Getting a sabbatical to complete the degree
- o Finding money to go back to school
- o "Finding an adviser willing to work with me"

* Advice to NSF Regarding The Minority Initiative:

- o "Provide money and lots of it, few Puerto Ricans can pay their own way"
- o "Provide money for schools to get kids hooked on science early; this means funding for junior scientists and engineers at elementary schools like mine"
- o Provide recruitment funds for universities to recruit in Puerto Rico as well as on the mainland

* Advice to Universities Regarding The Minority Initiative:

- o Provide language training facilities for students to polish English

National Science Foundation Interviews
Minority Non-Traditional Student Doctorate Recipients

NTS-9

Legend: NTS = Non-Traditional Student

* Present Post: Assistant Professor of Computer Engineering, University of Central Florida

* Elapsed Time, Baccalaureate to Ph.D.: six years

* Completed Baccalaureate at 33, Ph.D. at 39

* Major Field: Computer Engineering

* Ph.D. Granting University: University of Central Florida

* Baccalaureate Granting Institution: College of the Virgin Islands

* Master's Institution: University of Central Florida

* Primary Source(s) of Support: Florida Endowment Fund (master's and doctorate)

* Is not a veteran and did not attend a junior or community college

* Began college late and had to attend part-time because of marriage and family

* Three Most Challenging Doctoral Experiences:

  o Money, had a family to support and stipend did not fully cover expenses

  o Finding a dissertation topic and an adviser to direct the dissertation

  o Learning all of the requirements and meeting them

* Advice to NSF Regarding The Minority Initiative:

  o Provide family allowances in addition to basic stipends for married students with children

  o Stress choices available to NSF grantees re universities they may attend

  o Stress flexibility in moving from school to school to find dissertation topics and dissertation advisers

* Advice to Universities Regarding The Minority Initiative:

  o Advisers are vitally important, try to have the best take on minorities

National Science Foundation Interviews
Minority Non-Traditional Student Doctorate Recipients

NTS-10

Legend: NTS = Non-Traditional Student

* Present Post: Research Engineer, Bell Communications, Red Bank, NJ

* Elapsed Time, Baccalaureate to Ph.D.: 5 years

* Completed Baccalaureate at 25, Ph.D. at 30

* Major Field: Electrical Engineering

* Ph.D. Granting University: University of Florida

* Baccalaureate Institution: Southern University

* Master's Institution: University of Florida

* Primary Source(s) of Support: McKnight Foundation

* Is not a veteran, did not attend a junior or community college

* Three Most Challenging Doctoral Experiences:

  o Picking a topic

  o Getting an adviser to work with me

  o Finding another adviser when mine went to another university

* Advice to NSF Regarding The Minority Initiative:

  o Start early with elementary school children

  o Work very hard with high school students. Get universities and corporations to help

  o Provide ample financial aid. Most minority students have limited resources

* Advice to Universities Regarding The Minority Initiative:

  o Work hard to have advisers who want to work with minority students and who do this well

  o Have briefings for advisers on the above; find ways to reward them

APPENDIX C

INTERVIEW SUMMARIES: MINORITY SCIENCE AND ENGINEERING DOCTORAL PROSPECTS - CORPORATE WORKERS

National Science Foundation Interviews
Interview Schedule: Minority Corporate Workers

The National Science Foundation is mounting an initiative to increase the numbers of minority doctorate holders in science and engineering. Corporate S&E workers may comprise an excellent source of students for The NSF Initiative. We are pleased that you have agreed to chat with us about the initiative. We are sure that what you share with us will enhance NSF's efforts in this respect.

1. What is your corporate title? What type of work do you do?

2. Where did you complete your baccalaureate degree? In what field? When?

3. What is your marital status? Do you have children?

4. Have you ever thought about completing a doctorate in science or engineering?

5. Do you plan to pursue such a degree someday?

6. As you think about completing a doctorate in science and engineering, what, in your estimation, would be the biggest challenge you would face?

7. What could the National Science Foundation do to persuade you to enroll full-time in an S&E doctoral program? Examples: scholarship support, tuition waivers?

8. Speaking of scholarships and other supports, what kind of money would you need to be able to leave your job, enroll at a university and complete an S&E degree? Examples: amount of monthly stipend, types of health benefits.

9. In addition to scholarships and other support, what assurances would you have to have from the university you enroll in regarding the pursuit and eventual completion of an S&E doctorate? Examples: clear requirements for degree completion, clear schedule for completion.

10. What sorts of corporate or other courses have you completed which may be useful in the pursuit of an S&E doctorate?

11. What suggestions or advice can you offer the National Science Foundation as it moves ahead with its program to increase the number of science and engineering doctorates among minority populations? Examples: advertising and promoting the program, working with students who enroll.

12. Has our chat piqued or deepened your interest in study toward an S&E doctorate?

13. If so, how?

14. Would you like for me to pass your name on to someone looking to recruit likely candidates for the National Science Foundation's Minority Initiative?

15. Is there anything else you would like to add to our interview?

National Science Foundation Interviews
Minority Corporate Workers

CW-1

Legend: CW = Corporate Worker

Type of Work - Biologist

Firm: Monsanto Chemical Corporation

Location - St. Louis, MO

Baccalaureate Major - Biology

Years Away from Baccalaureate - 12

Marital Status - Married

* Ever thought about pursuing a Ph.D.? - Yes.

* Definite plans to pursue a Ph.D.? - No.

* Biggest challenge in completion of a Ph.D. - Time to degree completion.

* Necessary NSF inducement for enrollment in Ph.D. program - Full support, close to present salary.

* Level of support needed to study for the Ph.D. - $4000 a month - Tuition - Benefits.

* Assurances wanted/needed from university to study for the Ph.D. - No comment.

* Corporate courses completed which would be useful in Ph.D. study:

  o None. Has taken mainly management courses.

* Suggestions to NSF for assuring a successful Minority Initiative:

  o Work with elementary school students

  o Work with high school students

* Has chat/interview piqued interest in pursuing Ph.D.? - No.

* Anything else to add to our interview? - No.

* Would you like for me to pass on your name to someone connected with NSF's Minority Initiative? No.

National Science Foundation Interviews
Minority Corporate Workers

CW-2

Legend: CW = Corporate Worker

Type of Work - Electrical Engineering

Firm: IBM Corporation - St. Louis, MO

Baccalaureate Major - Electrical Engineering

Years Away from Baccalaureate - 1

Marital Status - Married

* Ever thought about pursuing a Ph.D.? - Yes.

* Definite plans to pursue a Ph.D.? - Not at the present time.

* Biggest challenge in completion of a Ph.D. - Problems in supporting a family. Would have to divide time between study and family.

* Necessary NSF inducement for enrollment in Ph.D. program - Scholarship with stipend.

* Level of support needed for Ph.D. study - Tuition - Books - Help with living expenses.

* Assurances wanted/needed from university to study for the Ph.D.:

- o Clear description of curriculum and requirements.
- o Everything must be clear, concise and in writing.

* Corporate courses completed which would be useful in Ph.D. study:

- o Advanced Computer Architecture. Microprocessor for 386 and 486

* Suggestions to NSF for assuring a successful Minority Initiative:

- o Advertise.
- o Have corporations work with universities to support doctoral students.

* Has chat/interview piqued interest in pursuing Ph.D.? - No. Already interested.

* Anything else to add to our interview? - No.

* Would you like for me to pass your name on to someone involved in NSF's new Minority Initiative? - Yes.

National Science Foundation Interviews
Minority Corporate Workers

CW-3

Legend: CW = Corporate Worker

Type of Work - Nuclear Engineer - St. Louis, MO

Firm: Union Electric Utilities

Baccalaureate Major - Nuclear Engineering

Years Away from Baccalaureate - 1

Marital Status - Single

* Ever thought about pursuing a Ph.D.? - Yes.

* Definite plans to pursue a Ph.D.? - Not at the present time.

* Biggest challenge in completion of a Ph.D. - Being a "penniless student" again. Getting back into studying again.

* Necessary NSF inducement for enrollment in Ph.D. program - Lots of money. Show why it is advantageous to get a Ph.D. degree in my field.

* Level of support needed for Ph.D. study - Tuition - 80% of salary - Benefits.

* Assurances wanted/needed from university to study for the Ph.D.:

- o Guarantee that with extra degree person would get job equal to or better than job that was left to pursue the degree; or be guaranteed that one could return to the same job with an appropriate salary increase.

* Corporate courses completed which would be useful in Ph.D. study:

- o None. Most courses comprised on-the-job training.

* Suggestions to NSF for assuring a successful Minority Initiative:

- o Recognize that it is hard to persuade a person to leave a good job.
- o Benefits of returning to school must be clearly delineated.

* Has chat/interview piqued interest in pursuing Ph.D.? - No.

* Anything else to add to our interview? - Perhaps a program where Ph.D. professors could come on the job site and talk to prospective students.

* Would you like for me to pass your name on to someone involved in NSF's new Minority Initiative? - Yes.

National Science Foundation Interviews
Minority Corporate Workers

CW-4

Legend: CW = Corporate Worker

Type of Work - Analytical Biochemist

Firm: Sigma Chemical Corporation - St. Louis, MO

Baccalaureate Major - Biology and Chemistry (Double Major).

Years Away from Baccalaureate - 1

Marital Status - Divorced

* Ever thought about pursuing a Ph.D.? - No.

* Definite plans to pursue a Ph.D.? - Maybe someday. Not now, however.

* Biggest challenge in completion of a Ph.D. - Working and attending school at the same time would be prohibitive.

* Necessary NSF inducement for enrollment in Ph.D. program - Full scholarship and a good stipend.

* Level of support needed for Ph.D. study - Tuition - 75% of salary - Benefits.

* Assurances wanted/needed from university to study for the Ph.D.:

o Clear requirements for degree completion, clear schedule for completing these requirements, clear alternatives for completion of requirements.

* Corporate courses completed which would be useful in Ph.D. study:

o None. Courses have been mostly on-the-job training.

* Suggestions to NSF for assuring a successful Minority Initiative:

o Introduce the program into schools with large minority populations. Provide incentives to enter certain fields.

* Has chat/interview piqued interest in pursuing Ph.D.? - Yes. How? Learned about prospects for tuition and stipend to return to school.

* Anything else to add to our interview? - Yes, biochemistry programs are almost totally lacking in colleges. Would have liked to have taken such a program.

*Would you like for me to pass your name on to someone involved in NSF's new Minority Program? - Yes.

National Science Foundation Interviews
Minority Corporate Workers

CW-5

Legend: CW = Corporate Worker

Type of Work - Pharmaceutical Chemist

Firm: Pharmaceutical Systems - St. Louis, MO

Baccalaureate Major - Chemistry

Years Away from Baccalaureate - 5

Marital Status - Married

* Ever thought about pursuing a Ph.D.? - No way.

* Definite plans to pursue a Ph.D.? - No.

* Biggest challenge in completion of a Ph.D. - Time. Degree would not improve salary at all. No incentive.

* Necessary NSF inducement for enrollment in Ph.D. program - Not much. Can't show why it is advantageous to get a Ph.D. degree in my field.

* Level of support needed for Ph.D. study - Tuition - $50,000 salary - Benefits.

* Assurances wanted/needed from university to study for the Ph.D.:

- o Crystal clear requirements. Ph.D. work can be very uncertain.

* Corporate courses completed which would be useful in Ph.D. study:

- o None.

*Suggestions to NSF for assuring a successful Minority Initiative:

- o Offer mentoring and tutoring programs in high schools. Enable more students to get going in study of science and engineering.

- o Benefits of returning to school must be clearly delineated.

* Has chat/interview piqued interest in pursuing Ph.D.? - No.

* Anything else to add to our interview? - No.

* Would you like for me to pass your name on to someone involved in NSF's new Minority Initiative? - No.

National Science Foundation Interviews
Minority Corporate Workers

CW-6

Legend: CW = Corporate Worker

Type of Work - Process Engineer

Firm: Mallinckrodt Corporation - St. Louis, MO

Baccalaureate Major - Chemical Engineering

Years Away from Baccalaureate - 10

Marital Status - Single

* Ever thought about pursuing a Ph.D.? - Yes.

* Definite plans to pursue a Ph.D.? - Yes. In my life plan.

* Biggest challenge in completion of a Ph.D. - Funding. Can't go back without it.

* Necessary NSF inducement for enrollment in Ph.D. program - Funding. Corporate support to provide summer work and continued corporate connections.

* Level of support needed for Ph.D. study - Tuition - 75% of salary - Benefits. First year should be full salary. Frontload the program.

* Assurances wanted/needed from university to study for the Ph.D.:

- o Support from chair of the department. Stability of adviser.

* Corporate courses completed which would be useful in Ph.D. study:

- o Quality improvement courses. Engineering specialty courses.

* Suggestions to NSF for assuring a successful Minority Initiative:

- o Recruit through National Society of Black Engineers.
- o Recruit through alumni clubs of universities.
- o Videotape promotional packages for both elementary and secondary schools.

* Has chat/interview piqued interest in pursuing Ph.D.? - Yes.

* Anything else to add to our interview? - Sponsor science camps to pique high school students' interest in graduate education in science.

* Would you like for me to pass your name on to someone involved in NSF's new Minority Program? - Yes.

National Science Foundation Interviews
Minority Corporate Workers

CW-7

Legend: CW = Corporate Worker

Type of Work - Medical Student - Paramedic (Part-time)

Firm: Abbott Ambulance Company - St. Louis, MO

Baccalaureate Major - Biology

Years Away from Baccalaureate - 2

Marital Status - Married

* Ever thought about pursuing a Ph.D.? - No.

* Definite plans to pursue a Ph.D.? - No. Plan to be a physician.

* Biggest challenge in completion of a Ph.D. - Preparation. My pre-med adviser was inadequate. Didn't point me to the right courses. Having a hard time in plain med school courses. Ph.D. work now seems remote.

* Necessary NSF inducement for enrollment in Ph.D. program - Not applicable.

* Level of support needed for Ph.D. study - Tuition - 80% of salary - Benefits.

* Assurances wanted/needed from university to study for the Ph.D.:

    o Be clear about what is required. Have heard stories of highly subjective Ph.D. programs. Whims of professor in charge jerk students around. Med school is hard but it is entirely clear. Standards are objective.

* Corporate courses completed which would be useful in Ph.D. study:

    o None. Taking some good courses, but most are limited to job training.

* Suggestions to NSF for assuring a successful Minority Initiative:

    o Start early. High school. Maybe even elementary school.

* Has chat/interview piqued interest in pursuing Ph.D.? - Not applicable. Plans to be a physician.

* Anything else to add to our interview? - Get the undergraduate school I attended on the ball. Better organized. Fire the professor who advised me.

* Would you like for me to pass your name on to someone involved in NSF's new Minority Program? - Not applicable.

National Science Foundation Interviews
Minority Corporate Workers

CW-8

Legend: CW = Corporate Worker

Type of Work - Quality Control Technician

Firm: Becks Flavors Ice Cream Company - St. Louis, MO

Baccalaureate Major - Biology

Years Away from Baccalaureate - 3

Marital Status - Married

* Ever thought about pursuing a Ph.D.? - Yes.

* Definite plans to pursue a Ph.D.? - Yes.

* Biggest challenge in completion of a Ph.D. - Orienting my personal life. Deciding on a major.

* Necessary NSF inducement for enrollment in Ph.D. program - Provide money. Enough money to enable me to attend school full-time.

* Level of support needed for Ph.D. study - Tuition - Stipend to meet monthly expenses. Would be willing to work part-time for some of this money.

* Assurances wanted/needed from university to study for the Ph.D.:

  o Support of faculty sensitive to minorities.

* Corporate courses completed which would be useful in Ph.D. study:

  o Worked in a research department. Lots of on-the-job training about research techniques.

* Suggestions to NSF for assuring a successful Minority Initiative:

  o Advertise. There are many programs out there but people don't learn about them. Post notices, send fliers. "Network hard."

* Has chat/interview piqued interest in pursuing Ph.D.? - Yes. Have been talking about returning to take a few classes. Firms up my decision.

* Anything else to add to our interview? - No. Program looks promising.

* Would you like for me to pass your name on to someone involved in NSF's Minority Initiative? - Yes.

National Science Foundation Interviews
Minority Corporate Workers

CW-9

Legend: CW = Corporate Worker

Type of Work - Environmental Analysis Testing

Firm: Eagle-Pitcher Corporation - St. Louis, MO

Baccalaureate Major - Biology

Years Away from Baccalaureate - 4

Marital Status - Single

* Ever thought about pursuing a Ph.D.? - Yes.

* Definite plans to pursue a Ph.D.? - Yes.

* Biggest challenge in completion of a Ph.D. - Day-to-day living expenses.

* Necessary NSF inducement for enrollment in Ph.D. program - Adequate scholarship assistance.

* Level of support needed for Ph.D. study - Tuition - 90% of salary - Benefits.

* Assurances wanted/needed from university to study for the Ph.D.:

- o Clear requirements for degree completion.

* Corporate courses completed which would be useful in Ph.D. study:

- o None.

* Suggestions to NSF for assuring a successful Minority Initiative:

- o Advertising.
- o Sponsor corporate workers with doctorates for trips to corporations.
- o Have corporations sponsor students in Ph.D. programs at full salary.

* Has chat/interview piqued interest in pursuing a Ph.D.? - Yes. Informative.

* Anything else to add to our interview? - No.

* Would you like for me to pass your name on to someone involved in NSF's Minority Initiative? - Yes.

National Science Foundation Interviews
Minority Corporate Workers

CW-10

Legend: CW = Corporate Worker

Type of Work - Housewife. Worked for awhile as a quality control technician.

Firm: Not employed at this time. Worked for McDonnell-Douglass for awhile.

Baccalaureate Major - Chemistry

Years Away from Baccalaureate - 1

Marital Status - Married

* Ever thought about pursuing a Ph.D.? - Yes.

* Definite plans to pursue a Ph.D.? - Yes.

* Biggest challenge in completion of a Ph.D. - Writing the dissertation.

* Necessary NSF inducement for enrollment in Ph.D. program - A scholarship.

* Level of support needed for Ph.D. study - Tuition - Books - Room and Board.

* Assurances wanted/needed from university to study for the Ph.D.:

  o Clear requirements for completing the degree.

* Corporate courses completed which would be useful in Ph.D. study:

  o None.

* Suggestions to NSF for assuring a successful Minority Initiative:

  o Advertise the program.

* Has chat/interview piqued interest in pursuing Ph.D.? - Yes. Had no idea NSF or anybody else was interested in minority students for Ph.D. degree study. Now I know. Can plan.

* Anything else to add to our interview? - Need more information about NSF scholarships.

* Would you like for me to pass your name on to someone involved in NSF's new Minority Program? - Yes.

National Science Foundation Interviews
Minority Corporate Workers

CW-11

Legend: CW = Corporate Worker

Type of Work - Research Biochemist

Firm: Monsanto Chemical Corporation - St. Louis, MO

Baccalaureate Major - Biology

Years Away from Baccalaureate - 5

Marital Status - Married

* Ever thought about pursuing a Ph.D.? - Yes.

* Definite plans to pursue a Ph.D.? - Possibly.

* Biggest challenge in completion of a Ph.D. - Financial aspects.

* Necessary NSF inducement for enrollment in Ph.D. program - Supplement whatever income I am able to earn while studying.

* Level of support needed for Ph.D. study - Scholarship equal to present salary.

- o Courses necessary for degree completion would be available - on schedule.
- o Program cancellation would not occur.

* Corporate courses completed which would be useful in Ph.D. study:

- o Several computer courses related to my job.

* Suggestions to NSF for assuring a successful Minority Initiative:

- o Key is reaching students at an early age.
- o Reach college students with graduate study prospects before they get into industry and start making money.
- * Has chat/interview piqued interest in pursuing a Ph.D.? - Yes.

* Anything else to add to our interview? - No. Glad to hear someone is interested in helping blacks further their education. Hope this works out.

* Would you like for me to pass your name on to someone involved in NSF's new Minority Program? - Yes.

APPENDIX D

INTERVIEW SUMMARIES: MINORITY SCIENCE AND ENGINEERING DOCTORAL STUDENT PROSPECTS - MILITARY PERSONNEL

Marian Brazziel Associates
National Science Foundation Interviews
Interview Schedule: Minority Military Personnel

Name -

Military Unit -
Rank -

Hometown -

Name of High School -

Off-Base College Attending or Attended -

Field of Study -

Type of Military College Attending or Attended (Community College of the Air Force, or other. Note: some students attend CCAF and off-base colleges) -

Field of Study -

Are you interested in Ph.D. study eventually? Yes? No?

If Yes, what field of study would you like to pursue?

If Yes, what sort of monthly stipend would you have to have to study for the Ph.D.? (Note to interviewee that most stipends total $1600 a month for nine months plus tuition and health benefits and that students teach or work in laboratories for 20 hours per week).

If No, do you need more information on what a Ph.D. is all about? Yes? No?. Explain if yes.

If No, do you need information on what Ph.D.s do? Yes? No?
Explain if yes.

If No, do you need information on what Ph.D.s make? Yes? No?
Explain if yes.

If No, do you need information on job prospects after completing the Ph.D.? Yes? No? Explain if yes.

Now are you interested in studying toward a Ph.D. degree?.

If Yes, what field of study would you like to pursue?

If Yes, what sort of stipend would you have to have to study for the Ph.D.?

If Yes, would you need help early on in understanding the requirements of the Ph.D. degree program? Help in having your family understand what the Ph.D. is all about? Help in housing? Getting into the program? Getting a good adviser?

National Science Foundation Interviews
Minority Military Personnel

MP-1

Legend: MP = Military Personnel

Military Unit - 104th Infantry, Massachusetts National Guard, Holyoke, MA

Rank - E4

Hometown - Holyoke, MA

Graduate - Holyoke High School

Currently Attending - Holyoke Community College

Field of Study - Transportation Technology

Support - Army National Guard - Tuition + Monthly pay

* Interested in Ph.D. study eventually - Yes

* Field of Interest - Mechanical Engineering

* Support Needed for Ph.D. Study - $1200 per month plus tuition, fees and benefits

* Other Needs:

More information on what a Ph.D. is all about

Information on what Ph.D.s do

Information on what Ph.D.s make

Information on job prospects after completing the Ph.D.

Guidance all through college on getting into a Ph.D. program

Help in transferring from the two-year college to a four-year college

Assistance with getting established on campus, e.g., housing

Help in understanding the requirements of the Ph.D. degree program

A good adviser who is "on his side"

A university which is "on his side"

Help in explaining his plans and aspirations to his parents

National Science Foundation Interviews
Minority Military Personnel

MP-2

Legend: MP = Military Personnel

Military Unit - 104th Infantry, Massachusetts National Guard, Springfield, MA

Rank - E4

Hometown - Springfield, MA

Graduate - Springfield Technical High School

Currently Attending - Springfield Technical and Community College (STCC)

Field of Study - Public Safety (Fire Equipment and Control)

Support - Army National Guard - Tuition + Monthly pay

* Interested in Ph.D. study eventually - Yes

* Field of Interest - Civil Engineering

* Support Needed for Ph.D. Study - $1800 per month plus tuition, fees and benefits

* Other Needs (Interviewee agreed to the suggestions for assistance listed below):

More information on what a Ph.D. is all about

Information on what Ph.D.s do

Information on what Ph.D.s make

Information on job prospects after completing the Ph.D.

Guidance all through college on getting into a Ph.D. program

Help in transferring from his two-year college to a four-year college

Assistance with getting established on campus, e.g., housing

Help in understanding the requirements of the Ph.D. degree program

A good adviser who is "on his side"

A university which is "on his side"

Help in explaining his plans and aspirations to his parents

National Science Foundation Interviews
Minority Military Personnel

MP-3

Legend: MP = Military Personnel

Military Unit - 91st Medical Technical Support Company, Massachusetts National Guard, Springfield, MA

Rank - Corporal

Hometown - Springfield, MA

Graduate - Springfield Technical High School

Currently Attending - Springfield Technical and Community College (STCC)

Field of Study - Medical Technology

Support - Army National Guard - Tuition + Monthly pay

* Interested in Ph.D. study eventually - Yes

* Field of Interest - Health Sciences, e.g., physical therapy, sports medicine

* Support Needed for Ph.D. Study - $2000 per month plus tuition, fees and benefits

* Other Needs (Interviewee agreed with the following suggestions for assistance)

More information on what a Ph.D. is all about

Information on what Ph.D.s do

Information on what Ph.D.s make

Information on job prospects after completing the Ph.D.

Guidance all through college on getting into a Ph.D. program

Help in transferring from the two-year college to a four-year college

Assistance with getting established on campus, e.g., housing

Help in understanding the requirements of the Ph.D. degree program

A good adviser who is "on his side"

A university which is "on his side"

National Science Foundation Interviews
Minority Military Personnel

MP-4

Legend: MP = Military Personnel

Military - 62nd Transportation Battalion, Massachusetts National Guard, Springfield

Rank - E2

Hometown - Springfield, MA

Graduate - Springfield Technical High School

Currently Attending - Not enrolled in school at present. Wants to "take a rest after putting in my 12 years." Plans to enroll at Springfield College later on, "maybe."

Field of Study - None (Not in school at present)

Support - If and when he enrolls, Army National Guard - Tuition + Monthly pay

* Interested in Ph.D. study eventually - Not at all sure. Would have to know more about it, think it over etc.

* Field of Interest - Mechanical engineering (maybe). Presently learning to overhaul trucks

* Support Needed for Ph.D. Study - No applicable

* Other Needs - Not applicable

National Science Foundation Interviews
Minority Military Personnel

MP-5

Legend: MP = Military Personnel

Military Unit - Discharged from the Air Force. Presently attending the University of Connecticut

Rank - Former Air Force Sergeant

Hometown - Danbury, CT

Graduate - Danbury High School

Former Community College of the Air Force student.

Currently Attending - University of Connecticut

Transferred 28 CCAF credits to the University of Connecticut

Field of Study - Psychology

Support - GI Bill

* Interested in Ph.D. study eventually - Yes

* Field of Interest - Psychology

* Support Needed for Ph.D. Study - $1800 per month plus tuition, fees and benefits

* Other Needs (Interviewee agreed with the following suggestions for assistance)

Affordable housing for family

Information on how to prepare for the Ph.D. program

Information on how to get into the program

Assistance in getting assistantships and fellowships

Guidance all through college on getting into a Ph.D. program

Assistance with getting established on campus, e.g., housing

Help in understanding the requirements of the Ph.D. degree program

A university which is "on his side"

Help in explaining his plans and aspirations to his fiancee

National Science Foundation Interviews
Minority Military Personnel

MP-6

Legend: MP = Military Personnel

Military Unit - Discharged Army veteran. Now attending the University of Connecticut

Hometown - Stamford, CT

Graduate - Stamford High School

Currently Attending - University of Connecticut

Attended Frederick Community College of Maryland while in the Army and stationed at Fort Meade, Maryland. Transferred 20 hours into the University of Connecticut

Field of Study - Physical Therapy

Support - GI Bill

Interested in Ph.D. study eventually - Maybe. Physical therapists usually work with master's degrees

Field of Interest - Health Sciences, e.g., physical therapy, sports medicine

Support Needed for Ph.D. Study - $1700 per month plus tuition, fees and benefits

Other Needs (Interviewee agreed with the following suggestions for assistance)

More information on what a Ph.D. is all about

Information on what Ph.D.s do

Information on what Ph.D.s make

Information on job prospects after completing the Ph.D.

Guidance all through college on getting into a Ph.D. program

Assistance with getting established on campus, e.g., housing

Help in understanding the requirements of the Ph.D. degree program

A good adviser who is "on his side"

A university which is "on his side"

Help in explaining his plans and aspirations to his parents and fiancee

National Science Foundation Interviews
Minority Military Personnel

MP-7

Military Unit - Recently discharged Army veteran. Former artillery sergeant stationed at Fort Sill, Oklahoma

Hometown - New Britain, CT

Graduate - New Britain High School

Currently Attending - University of Connecticut

Attended Cameron University (OK) while in the army. Transferred 32 credits into the University of Connecticut

Field of Study - Chemistry

Support - GI Bill

Interested in Ph.D. study eventually - Yes

Field of Interest - Chemistry. Wants to become a college professor

Support Needed for Ph.D. Study - $2000 per month plus tuition, fees and benefits

Other Needs (Interviewee agreed with the following suggestions for assistance)

Affordable housing near or on a campus

Clear explanation of benefits and responsibilities

Information on what Ph.D.s make

Guidance all through college on getting into a Ph.D. program

Help in transferring from the two-year college to a four year college

Assistance with getting established on campus, e.g., housing

Help in understanding the requirements of the Ph.D. degree program

A good adviser who is "on his side"

A university which is "on his side"

Help in explaining his plans and aspirations to his family

Help in setting up a "master plan"

National Science Foundation Interviews
Minority Military Personnel

MP-8

Military Unit - Air Transport Command, Westover Air Force Base

Hometown - Providence, RI

Graduate - Hope High School

Currently Attending - Community College of the Air Force

Attending Holyoke Community College for general education courses

Field of Study - Electronics

Support - CCAF now - GI Bill later

Interested in Ph.D. study eventually - Yes

Field of Interest - Electrical Engineering

Support Needed for Ph.D. Study - $1600 per month plus tuition, fees and benefits

Other Needs (Interviewee agreed with the following suggestions for assistance)

Affordable housing near or on a campus

Clear explanation of benefits and responsibilities

Information on what Ph.D.s make

Guidance all through college on getting into a Ph.D. program

Help in transferring from the two-year college to a four year college

Assistance with getting established on campus, e.g., housing

Help in understanding the requirements of the Ph.D. degree program

A good adviser who is "on his side"

A university which is "on his side"

Help in explaining his plans and aspirations to his family

Help in setting up a "master plan"

National Science Foundation Interviews
Minority Military Personnel

MP-9

Military Unit - Air Transport Command, Westover Air Force Base

Graduate - Bronx High School of Science

Currently Attending - Community College of the Air Force

Attending Westfield State College for general education courses

Field of Study - Health sciences now, genetics later. Wants to get into genetic engineering

Support - CCAF now - GI Bill later

Interested in Ph.D. study eventually - Yes

Field of Interest - Biology. Wants to do gene splicing - enhance food products

Support Needed for Ph.D. Study - $2500 per month plus tuition, fees and benefits

Other Needs (Interviewee agreed with the following suggestions for assistance)

Nice dormitory or campus apartment

Clear explanation of benefits and responsibilities

Information on what Ph.D.s make

Guidance all through college on getting into a Ph.D. program

Help in transferring from the two-year college to a four year college

Assistance with getting established on campus, e.g., housing

Help in understanding the requirements of the Ph.D. degree program

A good adviser who is "on her side"

A university which is "on her side"

Help in explaining her plans and aspirations to her family

Help in setting up a "master plan"

National Science Foundation Interviews
Minority Military Personnel

MP-10

Military Unit - Air Transport Command, Westover Air Force Base

Hometown - Boston, MA

Graduate - Boston Latin High School

Currently Attending - Community College of the Air Force

Attending University of Massachusetts for general education courses

Field of Study - Chemistry

Support - CCAF now - GI Bill later

Interested in Ph.D. study eventually - Yes

Field of Interest - Chemistry. Wants to become a corporate researcher

Support Needed for Ph.D. Study - $1600 per month plus tuition, fees and benefits

Other Needs (Interviewee agreed with the following suggestions for assistance)

- Affordable housing near or on a campus
- Clear explanation of benefits and responsibilities
- Information on what Ph.D.s make
- Guidance all through college on getting into a Ph.D. program
- Help in transferring from the two-year college to a four year college
- Assistance with getting established on campus, e.g., housing
- Help in understanding the requirements of the Ph.D. degree program
- A good adviser who is "on his side"
- A university which is "on his side"
- Help in explaining his plans and aspirations to his family
- Help in setting up a "master plan"

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